

DRAFT FINAL

**MUNITIONS AND EXPLOSIVES OF CONCERN
ENGINEERING EVALUATION/COST ANALYSIS
REPORT**

FOREST PARK

FUDS #B07M0098800

St. Louis, Missouri



Prepared by

**U.S. ARMY CORPS OF ENGINEERS
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ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
ASR	Archive Search Report
CWA	Clean Water Act
CWM	Chemical Warfare Materiel
DDESB	Department of Defense Explosive Safety Board
DERA	Defense Environmental Restoration Account
DERP	Defense Environmental Restoration Program
DNR	Department of Natural Resources
DoD	Department of Defense
DOJ	Department of Justice
DQO	Data Quality Objective
DSMOA	DoD and State Memorandum of Agreement
EE/CA	Engineering Evaluation/Cost Analysis
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ESS	Explosive Safety Submission
FM	titanium tetrachloride
FS	sulfur trioxide and chlorosulfonic acid mixture
FUDS	Formerly Used Defense Sites
GIS	Geographic Information System
HC	grained aluminum, zinc oxide, and hexachloroethane (C ₂ Cl ₁₆)
INPR	Inventory Project Report
KJ	stannic chloride
LTM	Long-Term Management
MCX	Mandatory Center of Expertise
MEC	Munitions and Explosives of Concern
MOA	Memorandum of Agreement
MSD	Minimum Separation Distance
NC	chloropicrin and stannic chloride
NCP	National Contingency Plan
NDAI	No DoD Action Indicated
NGVD	National Geodetic Vertical Datum

ACRONYMS AND ABBREVIATIONS

NOES	Non Ordnance-Related Scrap
NPL	National Priorities List
OE	Ordnance and Explosives
OERIA	Ordnance and Explosives Risk Impact Assessment
OES	Ordnance-Related Scrap
PDT	Project Delivery Team
ppm	parts per million
QC	Quality Control
RA	Response Action
RD	Response Design
SARA	Superfund Amendments and Reauthorization Act
SOW	Scope of Work
TH3	68.7% thermite, 29% barium nitrate, 2% sulfur, and 0.3% oil
TOP	Total Obscuring Power
TPP	Technical Project Planning
USACE	United States Army Corps of Engineers
UXO	Unexploded Ordnance
WP	White Phosphorous

ES. EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This report is the Engineering Evaluation/Cost Analysis (EE/CA) for the Forest Park Area of Concern (AOC). Forest Park is one of the largest urban parks in the United States and is located in the west central portion of St. Louis, Missouri.

ES.2 PURPOSE

The purpose of this EE/CA is to determine the most appropriate response action for the Forest Park AOC to address Munitions and Explosives of Concern (MEC) risk at the site. The following tasks were performed to achieve this purpose:

- Implemented the Technical Project Planning (TPP) process
- Conducted a site visit to the Forest Park AOC
- Prepared the EE/CA Work Plan
- Characterized the site through existing data and historical information (no field investigation)
- Performed a qualitative evaluation of MEC risk present
- Developed, assessed, and compared response action alternatives
- Recommended a risk reduction alternative
- Prepared the EE/CA report

ES.3 MILITARY USE

Documented military use of Forest Park began during World War I and continued through World War II. The only known military use of Forest Park was for public demonstrations and bivouacs, which were temporary encampments. In July 1942, the Army was granted permission to use 17 acres in the southeastern corner of Forest Park for a U. S. Army recreation camp. The camp was in operation for the duration of World War II and was closed in July 1948.

ES.4 MEC FOUND ON SITE

There have been five individual instances when MEC has been located within the Forest Park AOC. All five instances of MEC being found on the site occurred during ground intrusive construction activities. Four Stokes Mortars and one Livens Projector were discovered within the Forest Park AOC.

ES.5 CURRENT AND FUTURE LAND USE

Forest Park is currently used as an urban park for citizens of, and visitors to, the City of St. Louis. Activities occurring within the park include golfing, biking, jogging, and winter sports. Access is essentially unlimited throughout the park. Forest Park is expected to remain an urban park for the foreseeable future.

ES.6 RESPONSE ACTION ALTERNATIVES

The following four alternatives were defined and evaluated individually and comparatively to determine the most appropriate response action. The alternatives are:

- Alternative 1, No Department of Defense Action Indicated (NDAI)
- Alternative 2, Institutional Controls
- Alternative 3, Comprehensive Surface Clearance with Institutional Controls
- Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls

The term comprehensive in Alternatives 3 and 4 is meant to indicate that 100% of the AOC will be scanned or investigated.

ES.7 RECOMMENDATION

The four alternatives listed above were evaluated individually and comparatively based on the following criteria:

- Effectiveness
- Implementability
- Cost

Based on the evaluation of the response action alternatives, the recommended response action is Alternative 2, Institutional Controls. Further detail on the controls recommended is included in Chapter 6. This alternative was determined to be the preferred response action after comparative evaluation of all the response action alternatives.

1 INTRODUCTION

1.1 PROJECT AUTHORIZATION AND REGULATORY FRAMEWORK

1.1.1 In 1986, Congress established the Defense Environmental Restoration Program (DERP) under 10 U.S.C. 2701 et.seq. DERP directs the Secretary of Defense to “carry out a program of environmental restoration at facilities under the jurisdiction of the Secretary.”

1.1.2 In 1990, the Environmental Protection Agency (EPA) issued a revised National Contingency Plan (NCP). Under 40 CFR 300.120, the EPA designated the Department of Defense (DoD) to be the removal response authority for incidents involving DoD military weapons and munitions under the jurisdiction, custody, and control of the DoD.

1.1.3 Since the beginning of this program, the United States Army Corps of Engineers (USACE) has been the agency responsible for environmental restoration at Formerly Used Defense Sites (FUDS). In 2003, the Omaha District of USACE was designated as a Design Center for Ordnance and Explosives. For the Forest Park FUDS property, the Omaha District Ordnance and Explosives Design Center is the district responsible for preparing this EE/CA Report. The Kansas City District of USACE is the district in charge of project management at the Forest Park FUDS property.

1.2 PURPOSE AND SCOPE

1.2.1 The purpose of this Engineering Evaluation/Cost Analysis (EE/CA) is to characterize the nature, location, and concentration of munitions and explosives of concern (MEC) that may remain on site from former military activities at Forest Park, St. Louis, Missouri, and its affect on human use of the site. Reasonable risk management alternatives have been identified and response action alternatives have been developed to reduce MEC-related risks to human health and the environment. Costs associated with the various response action alternatives are included in the EE/CA Report. From these alternatives, a recommended response action is selected. Public comments and participation will be solicited during the draft final phase of this EE/CA report.

1.2.2 No fieldwork involving the detection, location, and mapping of MEC was required under the Forest Park EE/CA Scope of Work (SOW; Appendix A). The Project Delivery Team (PDT) based its investigation on the evaluation of archival data and information gathered during the Technical Project Planning Process. This EE/CA report, which includes an Ordnance and Explosives Risk Impact Assessment (OERIA), has been prepared based on information gathered from interviews and literature searches performed by the PDT. An Explosive Safety Submission (ESS) will be prepared and submitted to the Department of Defense Explosive Safety Board (DDESB) for approval. Upon completion of the EE/CA and approval of the ESS, an Action Memorandum that identifies the response action to be taken and the rationale behind the response action selection will be prepared.

1.2.3 The Area of Concern (AOC) investigated under the SOW is the Lower 9 of the former Forest Park Golf Course, now the Norman K. Probststein Community Golf course. This area includes Art Hill and the upper northwest part of Forest Park, north of Lagoon and Fine Arts Drive and west of Grand Drive. The total area is approximately 125 acres.

1.3 TECHNICAL PROJECT PLANNING TEAM

1.3.1 The Forest Park EE/CA PDT includes members from both USACE, Omaha District, and USACE, Kansas City District. The Missouri Department of Natural Resources (DNR) and the St. Louis Department of Parks, Recreation, and Forestry were also invited to participate in the TPP process to identify project objectives and design a data collection program to meet those objectives. The PDT used the Technical Project Planning (TPP) Process published in Engineer Manual 200-1-2 and Interim Guidance Document 01-02 from the USACE Ordnance and Explosive Center of Expertise. TPP is a four-phase process designed to identify project objectives and define the best methods for achieving those objectives. The details of the TPP process are recorded in the Forest Park EE/CA Work Plan (Appendix H; USACE, 2004). Members of the TPP team include the customer, project manager, regulators, and stakeholders.

1.3.1.1 The customer for this project is USACE, Kansas City District. USACE, Omaha District, was tasked by Kansas City District to complete this EE/CA investigation. Josephine Newton-Lund is the project manager from USACE, Kansas City District. Ms. Newton-Lund managed the funds and information exchange between the two districts. Joe Slattery is the ordnance and explosives project manager from USACE, Omaha District Design Center. Mr. Slattery coordinated the efforts of the PDT to deliver the EE/CA on time and within budget constraints.

1.3.1.2 Regulators involved in this project are the Missouri DNR and the EPA. The project manager from the Missouri DNR is Mark Ort. The project manager from the EPA is Diana Bailey. The EPA provided oversight and technical assistance if requested, but deferred decision-making to the Missouri DNR.

1.3.1.3 The stakeholders for this project are represented by the landowner, the City of St. Louis. The entire Forest Park site is owned by the City of St. Louis and is operated by the St. Louis Department of Parks, Recreation, and Forestry. The Norman K. Probststein Municipal Golf Course, a primary AOC at Forest Park, is operated by this department. Jeff Raffelson is the golf course representative who participated in this EE/CA investigation. The elected and appointed officials of the City of St. Louis indirectly represent the members of the public who utilize Forest Park. Members of the public will also have the opportunity to review, comment, and modify courses of action at Forest Park as part of the EE/CA process.

1.4 PUBLIC PARTICIPATION

1.4.1 The Forest Park EE/CA Report will be made available to the public for a thirty-day review and comment period at the draft final stage. This thirty-day public comment period is scheduled to occur from 13 July 2004 to 13 August 2004. A public availability session will occur during this public comment period. A public availability session allows concerned

members of the public to make comments and voice their concerns about the proposed course of action. The public availability session is scheduled for 13 July 2004. Notices will be published in St. Louis area newspapers to notify the public of the availability of the EE/CA report and the public availability session.

1.4.2 A responsiveness summary will be included in the Final Forest Park EE/CA Report. The purpose of the responsiveness summary is to respond to substantive comments received from the public during the thirty-day public comment period. Copies of the Final Forest Park EE/CA Report will be available at the Forest Park information repository located at the Central Branch of the St. Louis Public Library. Copies of the report can be transferred to other St. Louis Public Library branches throughout the city.

1.5 OTHER ENVIRONMENTAL CONTAMINATION

Two federal investigative documents have been produced for Forest Park. In 1995, an Inventory Project Report (INPR) was produced by USACE, Kansas City District, which included a site visit. In 1997, an Archive Search Report (ASR) was conducted by USACE, St. Louis District. No environmental contamination was identified from the site visit or literature review in either of these investigative efforts. In 2004, USACE, Omaha District, performed a site visit as part of this EE/CA investigation. No environmental contamination was observed during the site visit nor were concerns about environmental contamination raised during interviews with stakeholders. Based on best available information, there are no concerns related to other environmental contamination at Forest Park. This EE/CA is intended to address only MEC related concerns at the Forest Park AOC. If environmental contamination is discovered, it will be addressed under a different response action.

2 SITE DESCRIPTION

2.1 SITE LOCATION AND MAILING ADDRESS

Forest Park is located within the west central portion of the City of St. Louis, approximately 5 to 6 miles west of the downtown area. Forest Park is bordered by Highway I-64, Kingshighway Boulevard, Lindell Boulevard, and Skinker Boulevard (Figure 2-1). Forest Park is accessed from downtown St. Louis by taking I-64 West to Exit 34D (Forest Park/Museums) and continuing north into Forest Park. The Forest Park mailing address is 5600 Clayton Ave., St. Louis, MO, 63110.

2.2 PHYSICAL DESCRIPTION

2.2.1 Topography and Drainage

2.2.1.1 The topography of Forest Park and surrounding area is of the gently-rolling prairie type, with low rounded hills and broad shallow valleys. The Mississippi River to the east, the Missouri River to the north, and the Meramec River to the south have cut large valleys. Flowing into these rivers are numerous small tributaries with shallow valleys separated by low ridges.

2.2.1.2 The elevation in Forest Park varies from nearly 600 feet National Geodetic Vertical Datum (NGVD) on the southwest to about 460 feet NGVD on the north and east. The elevation throughout most of the park exceeds 500 feet NGVD.

2.2.1.3 Surface drainage is by sheet flow to the park's streets, then via the storm sewer system to the River des Peres. The River des Peres drains most of the northwest and west metropolitan St. Louis area, and has regularly flooded portions of Forest Park during the park's first half-century of existence. A bond issue, passed in 1923, allowed the stream to be put entirely underground in twin 23 feet high by 29 feet wide horseshoe-shaped storm sewers. Construction was completed in 1930. The river is now underground for its entire path through the park.

2.2.1.4 Flood waters are confined to the sewers except during rare high precipitation events when sewer surcharging and ponding within low areas of the park can occur. These ponds are within and near the old channel of the River des Peres, which is now used as a chain of recreation lakes. These areas generally extend along the north and east sides of the park. Ponding from River des Peres surcharging is of short duration, generally for less than 24 hours. Known or suspected MEC sites are generally believed to be on some of the higher areas of the park and are not expected to be impacted by occasional flooding. There are no hydrologic records of River des Peres or the unnamed small tributaries within the park boundary. All runoff from the park eventually flows into the Mississippi River via the River des Peres.

2.2.2 Climate

2.2.2.1 The City of St. Louis is near the confluence of the Missouri and Mississippi Rivers, and is also near the geographical center of the United States. Because of its central U.S. location, St. Louis feels the effects of warm moist air moving north from the Gulf of Mexico and cold air

masses moving south from Canada. The conflict along the frontal zones of these invading air masses provides a variety of weather conditions.

2.2.2.2 Winters are brisk with temperatures dropping to 0°F or below generally 2 or 3 days per year. The record low temperature at the current weather station site is -18°F, occurring in January 1985, although temperatures as low as -22°F have been measured at other area sites. Daily temperatures of 32°F or less occur less than 25 days per year, while temperatures of 90°F or higher occur approximately 35 to 40 days a year. The record high temperature for the area is 115°F, occurring in July 1954. Temperatures exceeding 100°F generally occur every other year, although some years may see 15 or more days with temperatures exceeding 100°F. The prevailing wind direction is from the south between May and November and from the northwest between December and April.

2.2.2.3 Precipitation averages approximately 36 inches per year. The winter months are the driest while the months of May through July are the wettest. Snowfall averages about 20 inches per season. Rainfall can be severe at times with as much as 8 inches of rain recorded in a 24-hour period in 1957. Thunderstorms occur between 40 and 50 days per year, with a few being severe, causing hail, damaging winds and tornadoes. Tornadoes have produced damage and loss of life in the St. Louis area. Climatological data for the area has been summarized in Table 2-1. This data was collected at the National Weather Service meteorological station at Lambert-St. Louis International Airport, approximately 8 to 9 miles north-northwest of the Forest Park site.

Table 2-1: Climatological Data, St. Louis, Missouri

Month	Temperature (°F)			Precipitation	Wind Velocity	Wind Direction
	Average Daily		Average Monthly			
	Min	Max	Mean	Average (in.)	(mph)	
January	19.9	37.6	28.8	1.90	10.6	NW
February	24.5	43.1	33.8	2.14	10.8	NW
March	33.0	53.4	43.2	3.36	11.8	WNW
April	45.1	67.1	56.1	3.63	11.4	WNW
May	54.7	76.4	65.6	3.93	9.5	S
June	64.3	85.2	74.8	3.78	8.8	S
July	68.8	89.0	78.9	3.99	8.0	S
August	66.6	87.4	77.0	2.78	7.6	S
September	58.6	80.7	69.7	2.85	8.1	S
October	46.7	69.1	57.9	2.77	8.9	S
November	35.1	54.0	44.6	3.13	10.1	S
December	25.7	42.6	34.2	2.54	10.4	WNW
Annual	45.3	65.5	55.4	36.66	9.7	S

Source: NOAA, 1992, Local Climatological Data of St. Louis, Missouri and NWS 1995, St. Louis WSCMO AP, St. Louis County, Missouri

2.2.3 Site Geology

2.2.3.1 The City of St. Louis lies at the northeast tip of the Ozark Uplift and is bordered on the north and east by areas altered by glaciers. The bedrock underlying the St. Louis area consists essentially of flat-lying sedimentary formations, mostly limestone. Bedrock formations exposed in the St. Louis area represent three separate geologic systems, the Ordovician, Mississippian, and Pennsylvanian, each of which was formed at a different interval of time in the earth's history. The Ordovician rocks include (from oldest to youngest) massive sandstone, dolomite, and moderate solution limestone. Overlying these formations are rocks of Mississippian age including cherty limestone, shale, and extensive solution limestone. Almost all of the bedrock formations in the St. Louis area have been covered by extensive deposits of windblown silt (loess) carried from the flood plains of the Missouri and Mississippi Rivers and deposited on the upland during post-glacial time. Residual clays formed in place on weathered bedrock are found where the loess cover is relatively thin. Recent unconsolidated deposits of sands, silts and gravels have been deposited by the Missouri and Mississippi Rivers since they began flowing through their present valleys thousands of years ago.

2.2.3.2 Forest Park site soils fall into three different soil profiles. These profiles are quite similar, and are intermingled with each other throughout the park. In general, the permeability of the site soils is moderately slow, and the depth to bedrock is 60 inches or greater.

2.2.3.3 The first profile consists of deep, moderately well drained soils in upland areas. These soils are generally comprised of 37 to 40 inches of reworked loess used as fill material, and consist of multicolored silty clay containing fragments of brick, glass, cinders, and other manmade materials. The upper 4 inches of the reworked fill material is brown silty clay. Below the reworked fill material to a depth of approximately 60 inches is dark yellowish-brown, mottled, firm silty clay.

2.2.3.4 The second soil profile that is commonly encountered within the site area is similar to the above profile, except the natural topography has not been altered appreciably by urban development. This profile consists of moderately to strongly sloping well-drained soil. The surface layer is dark yellowish-brown clay to a depth of approximately 9 inches. The subsoil is dark yellowish-brown silty clay to a depth of approximately 60 inches.

2.2.3.5 The third soil profile is again similar to the above two profiles. The surface layer is dark brown silty clay to a depth of approximately 5 inches. The subsurface layer is yellowish-brown silty clay to a depth of approximately 60 inches.

2.3 SITE HISTORY

2.3.1 Forest Park (Figure 2-2) is one of the largest urban parks in the country at 1,371 acres. It was dedicated at a large public ceremony on 24 June 1876. The Louisiana Purchase Exposition (also known as the 1904 World's Fair) used almost the entire western half of Forest Park and brought more than 19 million visitors to St. Louis. Of the structures built for the fair, only the Palace of Fine Arts (now the St. Louis Art Museum) and the birdcage in the St. Louis Zoo were built as permanent structures. The others were constructed with Plaster of Paris mixed with fibers, and were completely demolished after the fair ended. The River Des Peres, an original

feature of Forest Park, was forced underground in a wooden channel to make way for fair structures and exhibits. In 1923, the river was moved underground permanently.

2.3.2 Between 1911 and 1930, active recreation facilities were brought into the park. In 1995, the City of St. Louis adopted the Forest Park Master Plan to integrate the park's natural and man-made systems into a cohesive and mutually beneficial ecosystem. The Master Plan for the rehabilitation of Forest Park is continuing with an estimated cost of approximately \$100 million.

2.3.3 Currently, more than 12 million visitors a year visit Forest Park. Facilities at the park include the St. Louis Zoo, the St. Louis Science Center, the Jefferson Memorial Building, the St. Louis Art Museum, one 9-hole golf course, one 18-hole golf course, 19 tennis courts, numerous baseball fields, and many other attractions.

2.3.4 Due to the nature of this document, the remaining portion of the site history text will highlight historical military activities and the discovery of military munitions in Forest Park. Documented military use of Forest Park began with World War I. The only known military use of Forest Park was for public demonstrations and bivouacs. The following is a list of events that highlight military activities and the discovery of military munitions:

- A 6 April 1917 photograph shows members of 'A' Battery firing a cannon salute in Forest Park.
- In 1917, the Army tank 'Britannia' gave a demonstration in the park. Thousands of patriotic citizens followed the tank around the park.
- A 16 September 1917 photograph shows the 3rd Battalion, 5th Infantry marching through Forest Park.
- On 7 April 1918, a Liberty Parade and Mass Meeting was held at Art Hill in Forest Park.
- On 26 August 1918, the British Aviation Mission landed six aircraft in Forest Park as part of a demonstration.
- Fourth of July celebrations were held at Art Hill during World War I. These were of a patriotic nature and included the presence of the Armed Forces.
- In September of 1926, the city of St. Louis held the St. Louis Exposition. As part of the Exposition, Army troops from Jefferson Barracks, would present a mock World War I battle daily. On opening day, 4 September 1926, there was to be a parade and the exploding of 13 bombs to start the afternoon festivities. On 12 September 1926, an Army Dirigible was to land at the Exposition. During the Exposition, complaints were made concerning the loud retort of the "French" 75mm cannons. The officer in charge of the battery agreed to reduce the charges for the remainder of the Exposition. After the Exposition, the area was cleared of buildings and debris. The entire field was then plowed and reseeded for use in baseball games the following spring.
- In 1940, after the start of World War II, Fourth of July celebrations were held on Art Hill to demonstrate patriotism. These were similar to the celebrations held during World War I.
- On 4 July 1942, more than 5,000 troops came to Forest Park from Fort Leonard Wood to participate in a Fourth of July parade and rally. Many of the men camped in or near the park.

- In July 1942, the Army was granted permission to use 17 acres in the southeastern corner of Forest Park for a recreation camp. The camp accommodated approximately 1,500 men and was to operate for the duration of the war. By 1947, the camp was abandoned and contracts were made by the government to restore the southeast corner of the park. By 1 July 1948, restoration was completed and formal acceptance of the property was given to the government.
- On 8 August 1943, a mock battle took place around the Art Hill area of Forest Park, with soldiers from Jefferson Barracks. This mock battle included 350 soldiers, amphibious jeeps, a smoke screen, and a final assault up Art Hill. Prior to the public demonstration, the soldiers were encamped in a 15-acre bivouac area.
- In May 1988, workers installing a sprinkler system on the 3rd fairway of the 9-hole golf course uncovered a live 3" phosphorus Stokes mortar round. The workers thought the mortar round was a remnant from the 1904 World's Fair. The round was given to an individual, who thought it was a type of time capsule. The next week the individual tried opening the round and caused the phosphorus to ignite. The Maplewood Fire Department responded and was able to contain the phosphorous by burying the round. Army Captain Hank Counts of the Granite City Illinois Support Center, 50th Explosive Ordnance Disposal Detachment, responded to the incident. He recovered the round and disposed of it. He examined the site where the round was uncovered and visually identified what appeared to be fragments of other rounds.
- In December 2001, a 3" or 4" Stokes mortar was found by a bulldozer worker who was moving dirt. The police removed the round and it was later found to contain white phosphorus (WP).
- In May 2002, a 3" or 4" Stokes mortar was excavated by an irrigation-trenching machine at a depth of 18". The round was empty, but was presumed by the police department to have contained WP.
- In June 2002, a 4" Stokes mortar was found. Police removed it from the site.
- In July 2002, a construction worker excavated a Livens Projector during renovation work at the Grand Basin. The item was determined to be empty by the St. Louis Police Department Bomb and Arson Squad.

Incident Reports are included as Appendix J.

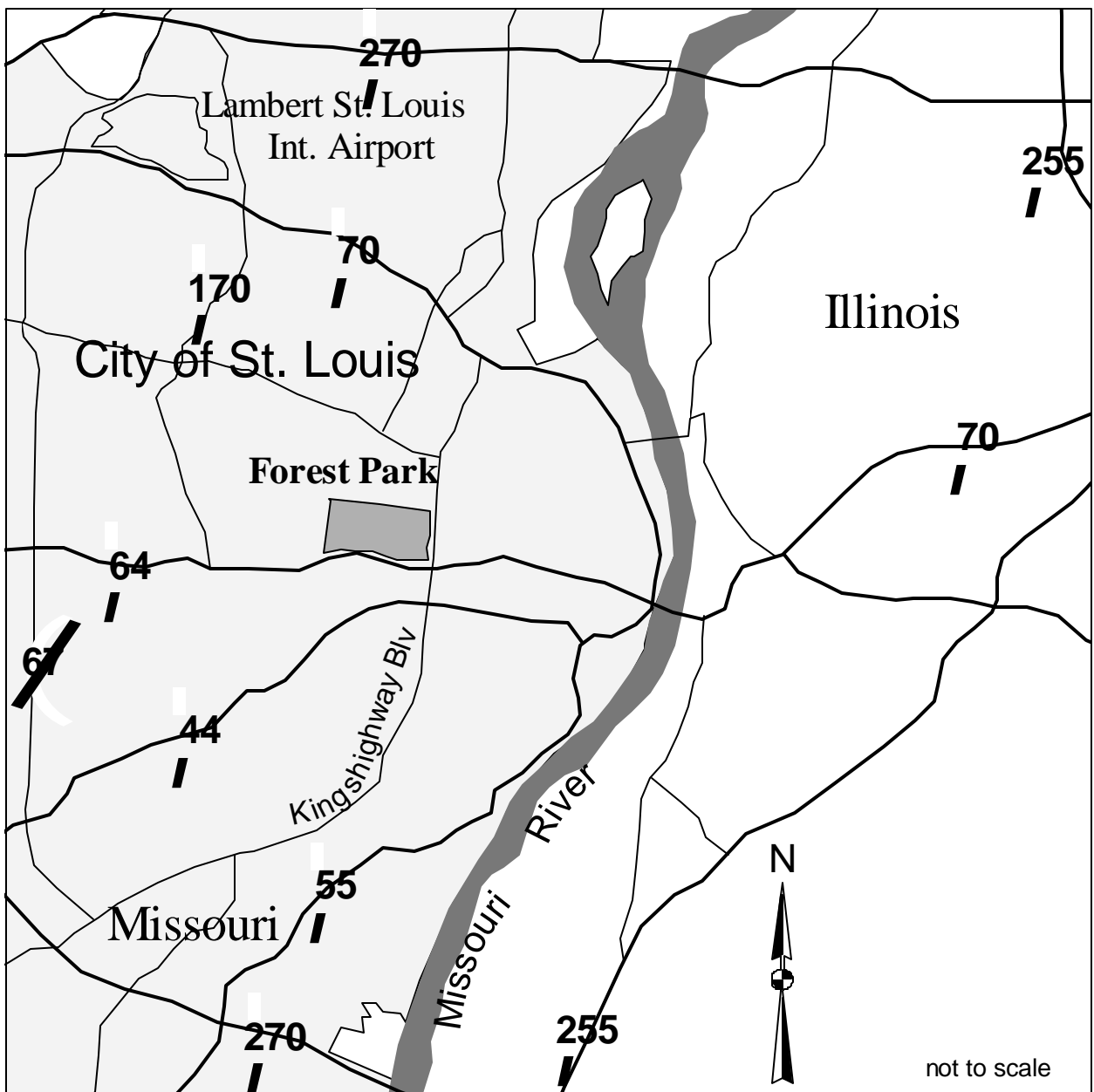
2.4 CURRENT AND PROJECTED FUTURE SITE USE

2.4.1 Current Site Use

Forest Park is currently used as a recreation area for the City of St. Louis. Facilities at the park include the St. Louis Art Museum, the St. Louis Zoo, the Missouri Historical Museum (Jefferson Memorial Building), the St. Louis Science Center, three 9-hole golf courses, 19 tennis courts, an ice and roller skating rink, and many other attractions.

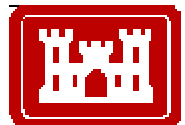
2.4.2 Projected Land Use

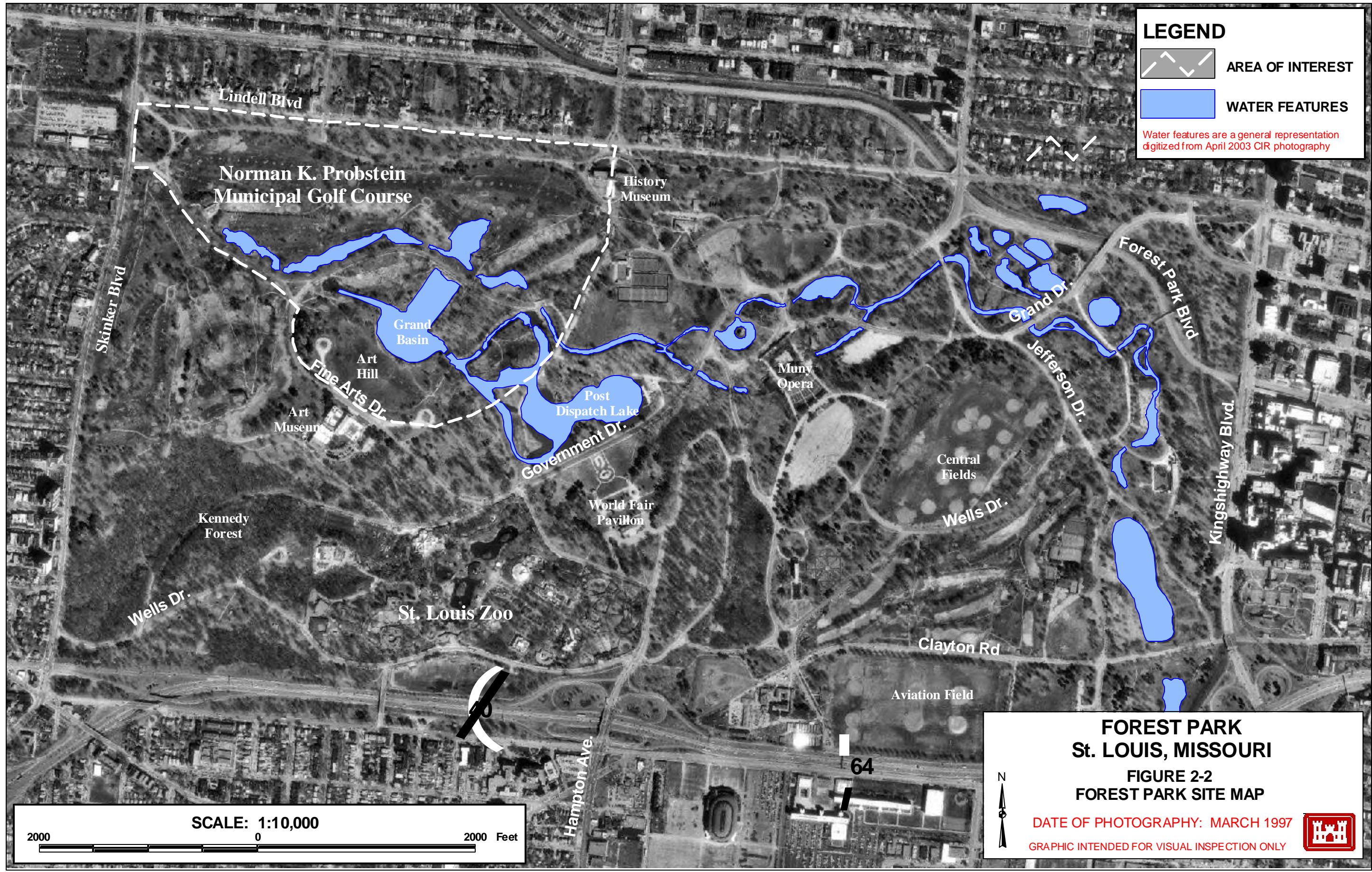
The projected land use is as a park for recreational use by the people of the City of St. Louis. As discussed in the site history section, the City of St. Louis adopted the Forest Park Master Plan in 1995 to integrate the park's natural and man-made systems into a cohesive and mutually beneficial ecosystem. The Master Plan for the rehabilitation of Forest Park is continuing with an estimated cost of approximately \$100 million. Therefore, it is expected that Forest Park will remain a recreation area for the foreseeable future.



**FOREST PARK
St. LOUIS, MISSOURI**

**FIGURE 2-1
FOREST PARK VICINITY MAP**

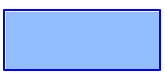




LEGEND



AREA OF INTEREST



WATER FEATURES

Water features are a general representation digitized from April 2003 CIR photography

**FOREST PARK
St. LOUIS, MISSOURI**

**FIGURE 2-2
FOREST PARK SITE MAP**

DATE OF PHOTOGRAPHY: MARCH 1997

GRAPHIC INTENDED FOR VISUAL INSPECTION ONLY



3 PROJECT OBJECTIVES

3.1 OVERALL PROJECT GOALS

The overall goals of the Forest Park EE/CA are to:

- Characterize the nature, location, and concentration of MEC within the site
- Provide a description of MEC-related problems affecting human use of the site
- Identify and analyze reasonable risk management alternatives
- Recommend a proposed alternative
- Seek public comments and participation
- Provide a convenient record of the process for use in final decision-making and judicial review, if necessary

3.1.1 Additional Project Objectives

Additional project objectives include:

- Continuing to allow public access to the site while reducing hazards associated with MEC
- Achieving site closeout in fiscal year 2004
- Identifying and outlining long-term monitoring procedures in a Memorandum of Agreement (MOA) between USACE and the City of St. Louis
- Establishing an information repository where the public can access information about the Forest Park project

3.2 REGULATORY/OTHER STAKEHOLDER CONCERNS

Concerns regarding Forest Park include ensuring that the property is safe for the intended use. Additional concerns expressed by stakeholders involved with activities occurring at Forest Park include interruptions to operations as a result of uncertainty with respect to MEC risk and the EE/CA process, and the potential for recurring reviews to interrupt the operations of city entities. These concerns were specifically noted by representatives involved in the day-to-day operations of the golf course. The golf course recently underwent a multi-million dollar renovation and any interruption of operations could have financial implications.

3.3 CONSTRAINTS

3.3.1 Funding is a potential constraint on the completion of the EE/CA process for Forest Park. The project funding was estimated based on quarterly funding levels and should be adequate for completion of the project. However, if unforeseen circumstances arise as a result of the EE/CA process, additional funding may be required to complete the project.

3.3.2 Public involvement and information obtained through public interviews could potentially act as a constraint on completion of this project. For example, if members of the public describe additional AOCs within Forest Park, the scope of the EE/CA report would need to be expanded and completion postponed. This outcome is not expected to occur at Forest Park.

3.3.3 The EE/CA report and associated documentation are scheduled for completion in September 2004. This schedule is extremely aggressive and requires participation and concurrence from several federal and local government agencies. Delay of the schedule for this project is not expected to occur.

3.3.4 The entirety of Forest Park is currently accessible to the public and is developed for current land use. If a determination were made to conduct surface or subsurface removal of MEC items, many areas of Forest Park would be closed to public access.

3.4 POSSIBLE RESPONSE ALTERNATIVE ACTIONS

3.4.1 The possible response action alternatives evaluated for Forest Park are:

- No Department of Defense Action Indicated (NDAI)
- Institutional Controls
- Comprehensive Surface Clearance with Institutional Controls
- Comprehensive Subsurface Clearance with Institutional Controls

3.4.2 No MEC response action, even using the best available technology, can completely remove all MEC risk for Forest Park. However, all of the MEC response actions considered (with the exception of NDAI) reduce the potential risks posed to the public by inadvertent ordnance detonation, resulting in a reduction of the MEC risk.

3.5 DATA QUALITY OBJECTIVES

3.5.1 The Data Quality Objective (DQO) for survey of the site was to obtain data to delineate the site that was Class I, third order or better, based on the North American Datum of 1983 and the Universal Transverse Mercator Grid System. This DQO was met.

3.5.2 The DQO for collection of historical information was met. Historical information was collected from the ASR for Forest Park, the INPR for Forest Park, and other documents. Interviews were conducted with stakeholders and individuals connected to Forest Park. The archives of the Missouri Historical Society and Washington University in St. Louis, Missouri were reviewed to determine if additional information existed regarding military presence and use of Forest Park.

3.5.3 Whether or not the DQO for public participation is met will be determined after the public availability session is conducted in July 2004. No members of the public were interviewed as part of the site visit conducted in February 2004. However, individuals employed by the City of St. Louis and Forest Park were interviewed as part of the site visit.

4 SITE CHARACTERIZATION

4.1 HISTORICAL RECORDS

Historical records reviewed for this EE/CA investigation included the ASR prepared by USACE, St. Louis District (USACE, 1997) and an INPR prepared by USACE, Kansas City District (USACE, 1995). Archives of the Missouri Historical Society and Washington University in St. Louis were also searched for additional information regarding past military usage of Forest Park. Based on the historical records located and reviewed, military usage of Forest Park was limited to bivouacs and demonstrations.

4.2 PERSONAL INTERVIEWS CONDUCTED

Several personal interviews were conducted with individuals employed by the City of St. Louis and Forest Park during a PDT site visit to Forest Park from 23-26 February 2004. Two interviewees referred to other individuals to be contacted. Those additional individuals were contacted. No new information was obtained from these personal interviews. Forms documenting the interview questions and answers provided are included as Appendix I of this EE/CA.

4.3 AERIAL PHOTOGRAPHY

Aerial photographs for the Forest Park site were obtained from the TerraServer web site, which can be accessed at <http://terraserver.microsoft.com/default.aspx>. Additional analysis of aerial photographs is ongoing and will be included as part of the information repository when completed. This additional analysis is being conducted as a separate action by the USACE, Engineer Research and Development Center, Topographic Engineering Center. Selected historical aerial photos for years covering expected use of Forest Park by the U.S. military will be analyzed. Although not part of this EE/CA project, this analysis is being performed as an additional source of information. Due to scheduling constraints, this action cannot be completed in conjunction with the Final EE/CA Report. If additional MEC areas are located as part of this action, the recommendations from this report will be revisited to ensure they are still protective.

4.4 SITE INVESTIGATIONS PERFORMED

This EE/CA relied on historic records review and qualitative site assessment to obtain additional information concerning past use of Forest Park. A geophysical or intrusive investigation to characterize the nature and extent of MEC was not performed at the AOC. Historic records indicate temporary structures used in the 1904 World's Fair were razed and buried in place on the Park grounds following the fair. Traditional geophysical techniques cannot distinguish between MEC and construction material, and no useful information could be obtained. In addition, fill material from what is now the Grand Basin was used to landscape the AOC during golf course construction and renovations. This fill material would make detection more difficult or impossible without digging into the ground surface. Cut and fill diagrams of the golf course

are included as Appendix K. The risk impact assessment reported in section 5 of this report concludes low baseline risk from MEC at the site based on sparse density and expected depth to MEC at the AOC do not warrant a geophysical investigation. Geophysical or intrusive investigations would disrupt current land use and require temporarily closing all or part of the golf course.

4.4.1 Instrumentation

As no geophysical instruments were used for this EE/CA investigation, this section is not applicable.

4.4.2 Quality Control of Geophysical and Positioning Instruments

As no geophysical and/or positioning instruments were used for this EE/CA investigation, this section is not applicable.

4.4.3 Unexploded Ordnance

MEC is identified as Unexploded Ordnance (UXO) if the recovered item is “a military munition that contains explosive, pyrotechnic, or a chemical agent and has been primed, fuze, armed, or otherwise prepared for action, and which has been fired, placed, dropped, launched, projected, and remains unexploded by design or malfunction” (USACE, 1998b). Five MEC items were identified from historical research performed during this EE/CA investigation (Figure 4-2).

4.4.4 Munition Constituents

Munition constituents are defined as any material originating from UXO, discarded or other military munitions, including explosive and non-explosive materials, and emission, degradation, or break down elements of such ordnance or munition. There is no indication that the munitions found were structurally compromised due to weathering; therefore, the munition constituents are assumed to have remained intact within the steel casing. The Stokes round found in 1988 was mistakenly identified as a time capsule and a man was exposed to white phosphorus upon opening the Stokes mortar, which indicates the condition of the mortar. In addition, much of the soil at the site has been moved during the extensive construction activities at this site and the exact location of the munitions (within 1 foot) is not known. Therefore, sampling for munition constituents would not be beneficial at this site.

4.4.5 Munition Debris

Munition debris is defined as remnants of munitions (e.g. penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or use. No munition debris was found during the site visit.

4.4.6 Recovered MEC

Five MEC items were identified from historical research performed during this EE/CA investigation.

4.4.7 Munition Debris Disposal

Munition debris disposal procedures are not covered because the EE/CA investigation required no fieldwork and no munition debris was found.

4.4.8 Surface Soil Sampling

No soil samples were collected for this EE/CA.

4.5 SOURCE, NATURE AND EXTENT OF MEC

The source, nature, and extent of MEC have been defined based on the findings and conclusions of the final ASR, historical records, and the TPP process.

4.5.1 Source

The ASR describes the source of the 3” or 4” Stokes mortars as one of the many public demonstrations held in and around the Art Hill area (Figure 4-1). The Stokes mortars were found on the Lower 9 of the Forest Park Golf Course, now the Norman K. Probststein Golf Course. This golf course was first established in 1916, which pre-dates the use of the Stokes mortar. The possibility that a civilian buried the round is remote. The course is in use during the day and the grounds keepers would have noticed nighttime burials the following day. The possibility that the Army buried the rounds after a demonstration is equally remote. A military burial would have been in cooperation with the grounds keepers and would not have been on a fairway. Therefore, the source for the MEC is unknown.

4.5.2 Nature

The MEC consists of four Stokes mortars and one Livens Projector. There are no historic documents, anecdotal references, or other indications that chemical warfare materiel (CWM) was used at Forest Park. The MEC found in Forest Park has been either empty or filled with white phosphorus.

4.5.3 Extent

The distribution of MEC at Forest Park is consistent with the known AOC, the Norman K. Probststein Municipal Golf Course and Art Hill area. The probability is low that additional MEC will be found in Forest Park. It is believed that the MEC was moved during past renovations of the golf course and surrounding areas. The historical use of MEC in Forest Park was not extensive and was only used for military demonstration exercises. Due the extensive renovation and regrading conducted on the park, it is not expected to find MEC on the surface. There are no anticipated major renovations in the future, only maintenance of the grounds. A map showing the location of MEC found at Forest Park is included as Figure 4-2.

4.6 DESCRIPTION OF HAZARDS OF SPECIFIC MEC ENCOUNTERED

MEC items encountered at Forest Park and dates of discovery are provided in Table 4-1. A description of each type of ordnance is provided in the following sections.

Table 4-1: MEC Encountered at Forest Park

Date	Ordnance Found
May 1988	3" Stokes mortar
December 2001	3" or 4" Stokes mortar
May 2002	3" or 4" Stokes mortar
June 2002	4" Stokes mortar
July 2002	Livens Projector

4.6.1 3" Stokes Mortar

The 3" Stokes mortar is often referred to as the Trench mortar. A diagram of the Stokes mortar is provided in Figure 4-3. A description of possible shells associated with this mortar follows.

4.6.1.1 The Mark I Shell is made up of a cylindrical steel casing, into which a forged steel base and head are screwed. To the base is attached a short steel tube, or cartridge container, which has 16 holes drilled in it to permit the flash from the cartridge to ignite the powder rings. The head has a hole through the center that permits the insertion of the drawn steel booster casing and has a threaded recess for the fuze. This recess is plugged with a threaded fuze hole plug to protect the threads from dirt and damage during storage and shipping.

4.6.1.2 The Mark II Shell differs from the Mark I only in the shell body construction, as the casing, head, and base are welded together. Both shells are loaded with a high explosive charge of either TNT or Nitrostarch.

4.6.1.3 The Mark III Practice Shell is made up of a cast-iron body with a threaded hole in the upper end for assembling a dummy fuze similar to the trench-mortar fuze, Mark VI. The complete round consists of one Shell, Mark III, a dummy fuze, and propellant charges as used with the high explosive round.

4.6.1.4 The Mark VI Fuze is an "all-ways acting" fuze, designed to function upon impact, regardless of the manner in which the shell strikes the ground. The safety pin is withdrawn by means of a safety pin ring immediately before dropping the shell into the muzzle of the gun.

4.6.1.5 The Mark I Booster is made up in cartridge form and is placed in the body casing in the shell, upon assembling the round immediately before firing. The booster consists of a paper cartridge that supports the detonator. The detonator is a commercial detonator or a No. 8 blasting cap.

4.6.1.6 The propellant charge consists of one green paper brass-tipped cartridge, loaded with 120 grains of sporting ballistite powder, and from one to three ring-shaped silk bags, each containing 110 grains of M.R. 31 ballistite powder.

4.6.2 4" Stokes Mortar

The complete 4-inch Stokes mortar consists of the shell body, burster, fuze, propellant charge, and filling. The projectile body is a cylinder, 4 inches in diameter, fabricated from drawn steel tubing or rolled metal with an overlapped weld.

4.6.2.1 The body contains a forward disk and a base disk. The forward or nose disk was machined to 4.178 inches in diameter and designed to retain the forward end of the burster tube and fuze. The base disk was also machined to 4.178 inches and designed to support the aft end of the burster tube and accommodate the cartridge container. The cartridge container is a steel cylinder 2.875 inches in length, 1 inch in diameter, and perforated with 16 holes to provide outlets for the gases generated by the propellant. The forward end (or nose disk) and base disk serve as guides when the round is expelled from the mortar barrel. (Note: U.S. used British version as well as U.S. version of Stokes mortar).

4.6.2.2 The total body length of the body assembly varied, depending on the type of filling that was required. For example, the 4-inch Stokes mortar round filled for smoke was 18.56 inches long; and the round designed for incendiary was 17.56 inches long. A diagram of the 4" Stokes mortar is included as Figure 4-4. Fill and weight specifications are provided in Table 4-2.

Table 4-2: Fill and Weight Specifications for 4" Stokes Mortar

Type of Fill	Fill Weight		Total Weight with Fill	
	Kilograms	Pounds	Kilograms	Pounds
TH3 (Thermite)	See Note	See Note	See Note	See Note
WP (White Phosphorous)	See Note	See Note	See Note	See Note

Note: The Stokes mortar round fill weight was between 6.3 and 9.5 pounds (2.8 to 4.3 kg). The weight depended on the chemical agent in the round. A 4-inch Stokes mortar round filled and completely assembled could weigh up to 25 pounds (11.36 kg).

4.6.2.3 Tabulated Data

Length: 17.56 inches (44.6 cm) – 19.56 inches (49.68 cm) (depending on lot)

Diameter: 4.178 inches (10.61 cm) (end and base disks)
4 inches (10.16 cm) (body)

4.6.2.4 Description of Fills

4.6.2.4.1 TH3

TH3 is a mixture of 68.7% thermite, 29% barium nitrate, 2% sulfur, and 0.3% oil. It was used, primarily, in incendiary magnesium bombs. The TH3 is ignited by a primer, which burns, melts, and ignites the magnesium body.

4.6.2.4.2 *White Phosphorous (WP)*

White Phosphorous is a solid that is used primarily for screening purposes. It also has been used against personnel and fortifications. It burns vigorously when exposed to air and creates a dense, white cloud.

4.6.2.5 Markings

World War I Markings for the 4" Stokes mortar are provided in Table 4-3. World War II markings are provided in Table 4-4.

Table 4-3: World War I Markings, 4" Stokes Mortar

World War I					
Type of Fill	Color Bands			Other	
	1st Band	2nd Band	3rd Band	Body Color	Stencil Markings
TH3 (Thermite)	None	None	None	Gray	THERMITE
WP (White Phosphorous)	Yellow	None	None	Gray	SMOKE

Table 4-4: World War II Markings, 4" Stokes Mortar

World War II					
Type of Fill	Color Bands			Other	
	1st Band	2nd Band	3rd Band	Body Color	Stencil Markings
TH3 (Thermite)	Purple	None	None	Gray	TH, Incendiary
WP (White Phosphorous)	Yellow	None	None	Gray	WP, SMOKE

4.6.2.6 Explosive Train

Fulminate of mercury: unknown weight
 Tetryl: unknown weight
 Black Powder: 0.297 ounce (8.43 g)

4.6.2.7 Fuze

Model Number: M-X1
 Total Weight: 1 pound, 9 ounces (709.4 g)
 Overall Length: 2.659 inches (6.75 cm),
 M-X1, 2.5 inches (6.35 cm)

4.6.2.8 Burster

The burster consists of a detonator, which contains fulminate of mercury, and a 0.5-inch-diameter central tube filled with tetryl.

4.6.2.9 Engineering Data

Body: drawn steel tubing or rolled metal with an overlapped weld
 Wall Thickness: 0.188 inch (4.78 mm)

4.6.3 Livens Projector

4.6.3.1 The body MK II was made of seamless drawn steel tubing 0.188 inches thick with forge-steel welded hemispherical ends. It can be identified by the projections at each end, which were 1.69 inches in diameter and approximately 1 inch long. The projectile had a capacity of approximately 660 cubic inches. A central tube ran the length of the round and was welded into the round at both ends. A steel plug (coupling plug) was welded into the tube to divide it into the section used to receive the burster tube and the section used for filling. The filling passed from the tube into the round through four holes located near the filling end. There were also two vent holes. After filling, the round was sealed by screwing a tapered plug into the filling hole.

4.6.3.2 The MK IIA1 body differed in construction in that the hemispherical ends were closed by fusion welding. The MK IIA1 had a capacity of 716 cubic inches. The remaining details of the MK IIA1 were the same as the MK II. A diagram is included as Figure 4-5.

4.6.3.3 During World War I, titanium tetrachloride (FM) was a common smoke filling in the Livens projectile with a total fill weight of 30 pounds. Fill weights and specifications are provided in Table 4-5.

Table 4-5: Fill and Weight Specifications for Livens Projector

Type of Fill	Fill Weight		Total Weight with Fill	
	Kilograms	Pounds	Kilograms	Pounds
Screening Smoke (HC)	12.72	28	Unknown	Unknown
Titanium Tetrachloride (FM)	13.64	30	28.63	63
FS	12.72	28	27.73	61
Thermite ²	Unknown	Unknown	Unknown	Unknown
Incendiary Oil ²	Unknown	Unknown	Unknown	Unknown

¹French origin, not used by U.S. in World War I. Improved by the U.S. after the war, with some change in components. Became known as HC.

²Thermite was used to a limited extent. The chief incendiary fill was an inflammable oil in which balls of cotton were immersed.

4.6.3.4 Tabulated Data

Length:

MK II Shell Body: 21.62 inches (549.1 mm)

MK IIA1 Shell Body 23 inches (584.2 mm)

Diameter:

MK II Shell Body: 7.62 inches (193.5 mm)

MK IIA1 Shell Body 7.75 inches (196.8 mm)

4.6.3.5 Description of Fills

4.6.3.5.1 HC

HC was used as a screening smoke. It is a mixture of grained aluminum, zinc oxide, and hexachloroethane (C₂Cl₁₆). It has a TOP of 2100. It has no physiological action in exposed personnel.

4.6.3.5.2 Titanium tetrachloride (FM)

Titanium tetrachloride is a colorless, highly refractory liquid that boils at 136 degrees C (277 degrees F). It reacts with the moisture in the air and will evolve into dense clouds of acrid white smoke with a TOP of 1900.

4.6.3.5.3 FS

FS is a mixture of sulfur trioxide and chlorosulfonic acid. It is a liquid that freezes at -30 degrees C (-22 degrees F) and boils at 80 degrees C (176 degrees F). When FS is atomized in the air, it hydrolyzes with moisture that is present to produce a smoke with a TOP of 2,550.

4.6.3.6 Markings

Markings for the Livens Projector during World War I (MKII) are provided in Table 4-6. World War II (MK IIA1) markings are provided in Table 4-7.

Table 4-6: World War I Markings, Livens Projector

World War I (MK II)					
Type of Fill	Color Bands			Other	
	1st Band	2nd Band	3rd Band	Body Color	Stencil Markings
Titanium Tetrachloride (FM)	Yellow	Yellow	None	Slate gray	FM, gas
FS	Yellow	Yellow	None	Slate gray	FS, gas
HC	Yellow	None	None	Slate gray	HC, gas

World War I (MK II)					
Type of Fill	Color Bands			Other	
	1st Band	2nd Band	3rd Band	Body Color	Stencil Markings
High Explosive	None	None	None	Slate gray	H.E.
Thermite	Purple	None	None	Slate gray	Incendiary
Incendiary oil	Purple	None	None	Slate gray	Incendiary

Note: Stencil will be in 1-inch block letters, lengthwise of the drums.

Table 4-7: After 1925 Markings, Livens Projector

After 1925 (MK IIA1)				
Type of Fill	Color Bands		Other	
	1st Band	2nd Band	Body Color	Stencil Markings
Titanium Tetrachloride (FM)	Yellow	None	Blue-gray	SMOKE
FS	Yellow	None	Blue-gray	SMOKE
HC	Green	None	Blue-gray	SMOKE

4.6.3.7 Explosive Train

Fulminate of mercury: unknown
Tetryl: unknown
Black Powder: 0.297 ounce (8.43 g)

4.6.3.8 Fuze

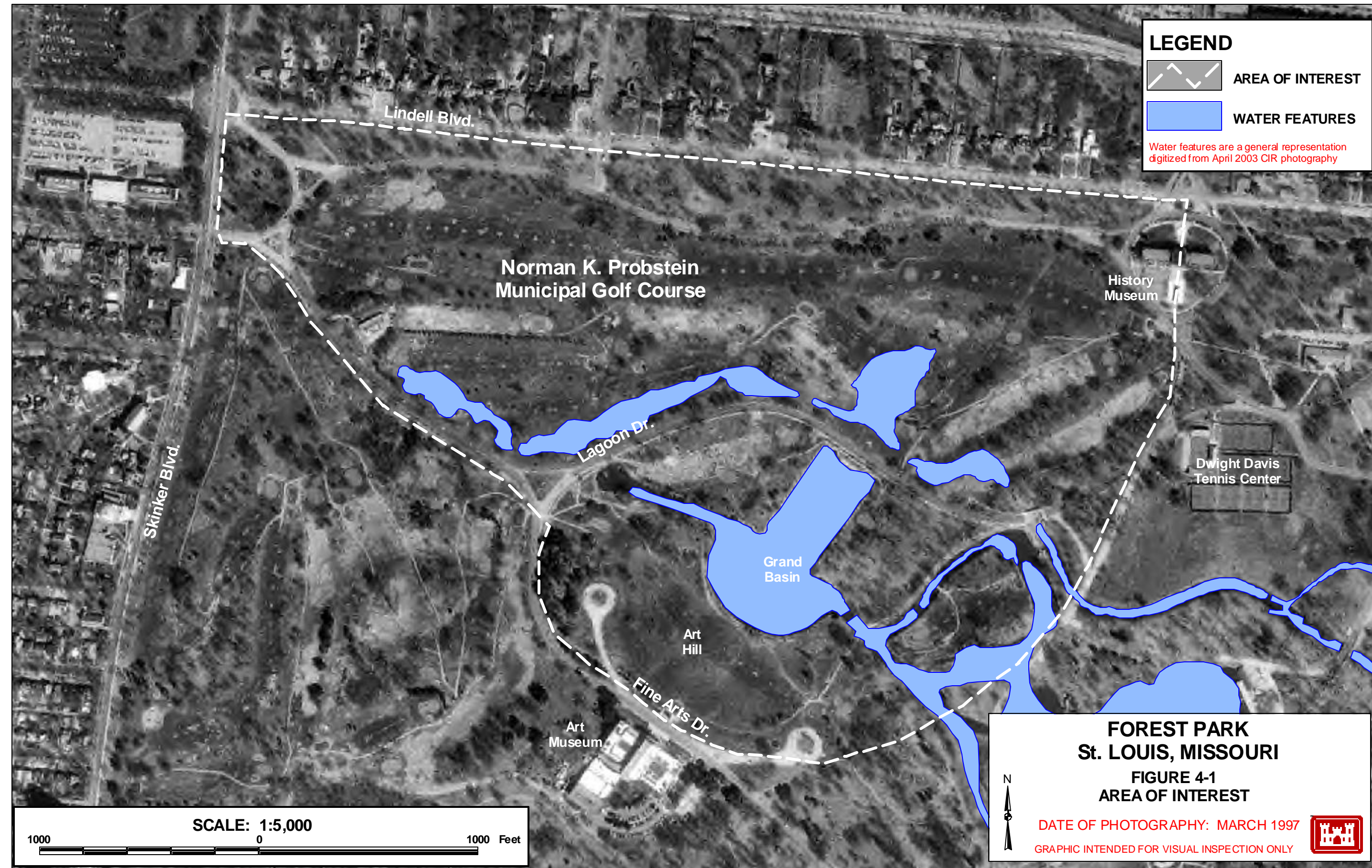
Model Number: Bickford
Total Weight: unknown

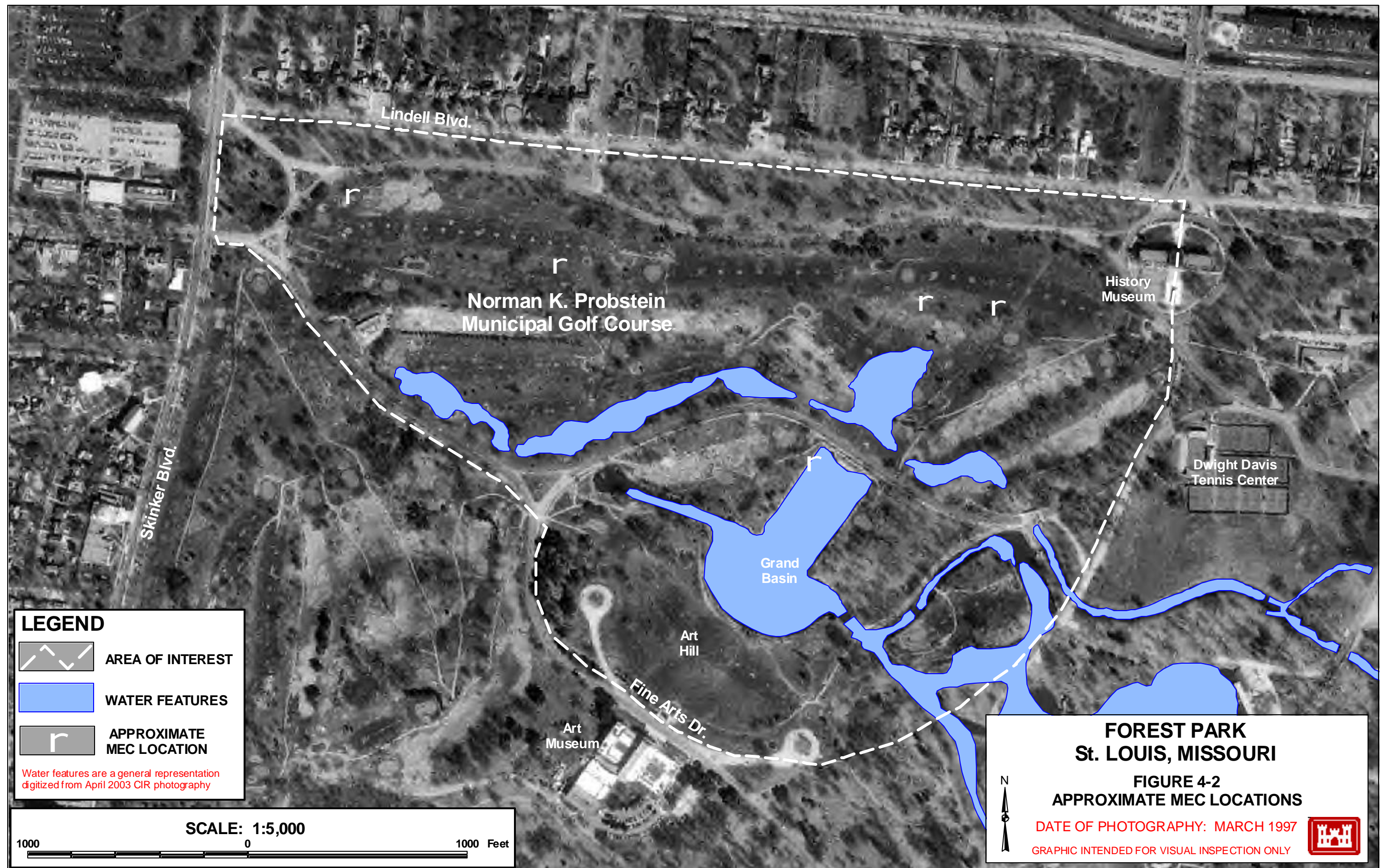
4.6.3.9 Burster

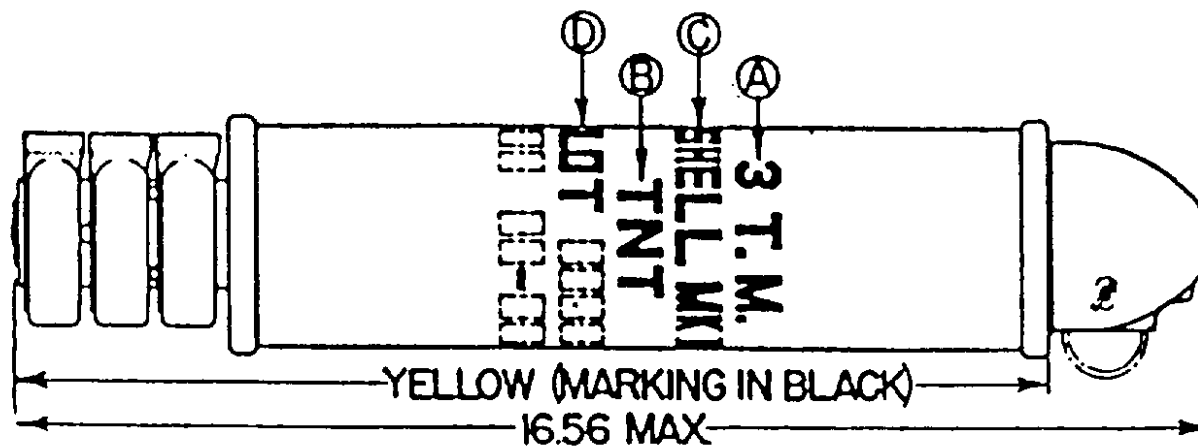
Model Number: M1
Diameter: unknown
Length: length of interior shell
Explosive type: TNT
Explosive weight: 2.11 ounces (59.87 g)

4.6.3.10 Engineering Data

Body: seamless drawn steel tubing
Wall Thickness: 0.188 inch (4.78 mm)







A - CALIBER OF MORTAR

B - TYPE OF FILLER

C - MODEL OF SHELL

D - AMMUNITION LOT NUMBER

FIGURE 4-3

3" STOKES MORTAR

Forest Park EE/CA
St. Louis, MO

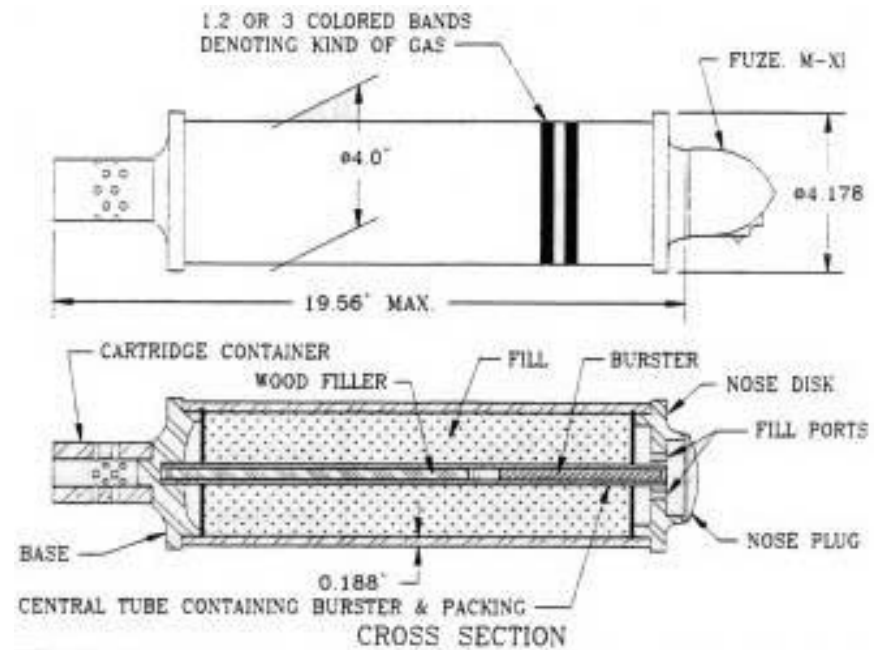


FIGURE 4-4

4" STOKES MORTAR

Forest Park EE/CA
St. Louis, MO

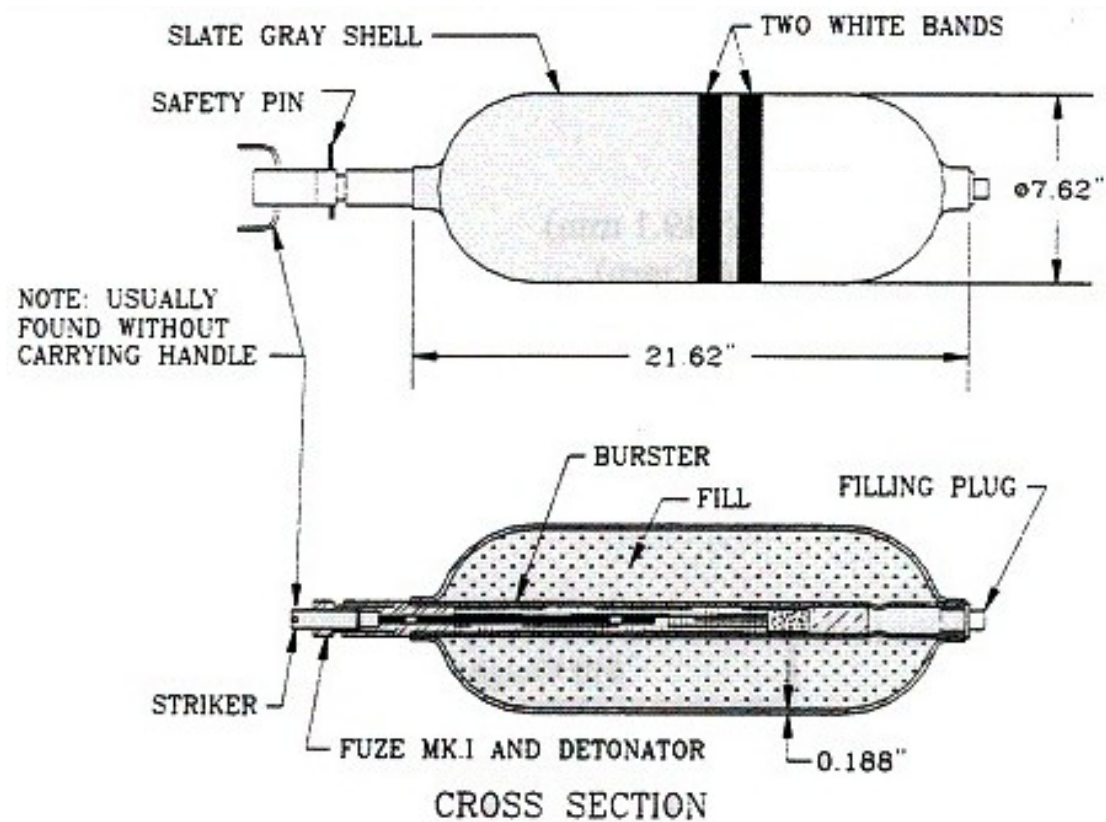


FIGURE 4-5

LIVENS PROJECTOR

Forest Park EE/CA
St. Louis, MO

5 RISK EVALUATION

5.1 CONCEPTUAL SITE MODEL

5.1.1 The Conceptual Site Model (CSM) for Forest Park was developed during the TPP Process and refined during the EE/CA to describe the exposure routes for MEC to a human receptor. It is depicted graphically in Figure 5-2 and described here. The potential for an explosive safety risk depends upon the presence of three elements: a source, a receptor, and an interaction between the source and the receptor. There is no risk if any one element is missing. Each of the three elements provides a basis for implementing effective risk-management response actions.

5.1.2 Human activity at Forest Park is substantial with millions of people visiting one or more attractions annually, and as many as 80,000 rounds of golf are played each year. In addition to golfers, the AOC is regularly maintained and the grounds keeper is included in the CSM. Forest Park is undergoing renovations and may do so again, so a construction worker is also included in the CSM.

5.1.3 The exposure route for MEC to a receptor is primarily direct contact as a result of some human activity. MEC will tend to remain in place unless disturbed by human activities, such as agriculture, or natural forces, such as erosion. Movement of MEC may increase the probability for direct human contact but not necessarily result in a direct contact or exposure.

5.1.4 The source area of MEC risk to humans is MEC in the subsurface at the Lower 9 of the Forest Park Municipal Golf Course and Art Hill. MEC is not expected to exist on the surface of the golf course so pathways to human exposure from MEC on surface soil are considered incomplete. If MEC exists, it would be in the subsurface, occurring at depths greater than six inches below the ground surface.

5.1.5 The golfer and grounds keeper as well as other visitors to Forest Park are not expected to engage in activities that expose the subsurface material under ordinary circumstances. Their activities include golfing, mowing, walking, picnicking, and sightseeing among many other recreation possibilities. The construction worker is likely to dig below the ground surface to install utilities, grade the surface, or build foundations for permanent structures. The CSM shows incomplete pathways for golfers and grounds keepers, and potentially complete exposure pathways for constructions workers.

5.2 RISK IMPACT ASSESSMENT

Risk Impact Assessment is a tool used to evaluate safety hazards to people posed by MEC. The risk impact assessment was performed in accordance with Interim Guidance 01-01, Ordnance and Explosives Risk Impact Assessment, from the U.S. Army Engineering and Support Center (USACE 2001). Risk impact assessment is a stakeholder-friendly method of risk assessment for use during MEC site EE/CA evaluations. Statistically based risk assessment techniques are not possible for this EE/CA because no geophysical data was collected. This method uses direct

evaluation of site conditions and human issues that create MEC risk. The results of the risk impact assessment are an input into the evaluation of the effectiveness criterion of the EE/CA response alternatives evaluation. The three processes in the risk impact assessment method are:

- Evaluate base risk factors
- Perform a baseline risk assessment
- Assess response action alternatives

5.3 BASE RISK FACTORS

The potential risk posed by MEC was characterized qualitatively by evaluating the presence of MEC factor, site characteristics factor, and human factor. By qualitatively assessing these three factors, an overall assessment of the safety risk posed by MEC was evaluated. The following sections describe the components of each of the primary risk factors. An overview of the risk evaluation factors is included as Figure 5-1.

5.3.1 Presence of MEC Factor

Four categories are used to evaluate the presence of MEC risk factor: MEC type, sensitivity, density, and depth distribution.

5.3.1.1 Type

MEC type affects the likelihood of injury and the severity of exposure. If multiple MEC items are identified in an area, that item which poses the greatest risk to public health is selected for risk evaluation. There are four subcategories of MEC type, as described in Table 5-1. These subcategories are presented in order of severity from highest to lowest risk.

Table 5-1: MEC Type

Category		Description
Most severe	3	MEC that may be lethal to an individual if detonated by an individual's activities
Moderately severe	2	MEC that may cause major injury to an individual if detonated by an individual's activities
Least severity	1	MEC that may cause minor injury to an individual if detonated by an individual's activities
No injury	0	Ordnance scrap (inert), will cause no injury

5.3.1.2 Sensitivity

MEC sensitivity affects the likelihood of detonation and the severity of exposure. Sensitivity is a factor of fuzing. MEC in the environment is subject to conditions such as weathering and

movement by erosion. There are four subcategories of MEC sensitivity. The category of sensitivity is based on the results of the EE/CA investigation as well as the results of archival searches. The subcategories of sensitivity are defined and presented in order from highest to lowest in Table 5-2.

Table 5-2: MEC Sensitivity

Category		Description
Very Sensitive	3	MEC that is very sensitive, i.e. electronic fuzing, land mines, booby traps
Less sensitive	2	MEC that has standard fuzing
Insensitive	1	MEC that may have functioned correctly, or is unfuzed, but has a residual risk
Inert	0	Ordnance scrap (inert), will cause no injury

5.3.1.3 Density

MEC density affects the likelihood that an individual will be exposed to MEC. There is a direct relationship between density and the potential for harm. More ordnance per acre means a greater likelihood of exposure. Density can be estimated either qualitatively or quantitatively.

5.3.1.4 Depth Distribution

MEC depth distribution refers to where the MEC is located vertically in the subsurface. The MEC depth distribution affects the likelihood that an individual will be exposed to MEC. There is an inverse relationship between the depth at which MEC are found and the likelihood of exposure to the MEC. The deeper the MEC is located, the lower the risk of exposure. There are two subcategories within the MEC depth distribution category: surface and subsurface. The surface subcategory includes those items recovered either on the ground surface, protruding from the ground surface, or beneath the leaf litter. The subsurface subcategory includes those items recovered from beneath the ground surface.

5.3.2 Site Characteristics Factor

Two categories are evaluated in the site characteristics factor. These are site accessibility and site stability.

5.3.2.1 Site Accessibility

The accessibility of a site affects the likelihood of encountering MEC. Natural or physical barriers can limit accessibility. Natural barriers include the terrain or topography of the site as well as the vegetation. Physical barriers include walls and fences that limit the public's accessibility to the site. Both physical and natural barriers found are considered when evaluating this category. Site accessibility has three subcategories. These subcategories are presented in the Table 5-3.

Table 5-3: Site Accessibility

Category	Description
No Restriction	No man-made barriers Gently sloping terrain Vegetation that restricts access Water that restricts access
Limited Restriction	Man-made barriers Vegetation that restricts access Water, snow or ice cover, and/or terrain restricts access
Complete Restriction	All points of entry are controlled

5.3.2.2 Site Stability

This category relates to the probability of being exposed to MEC by natural processes. These natural processes include recurring natural events (e.g. erosion and frost heave) or extreme natural events (e.g., severe wind and flash floods). The local soil type, topography, climate, and vegetation all affect the stability of the site. Soil type and climate will affect the depth of penetration of MEC. Over time, the soil type and climate will also affect the degree of erosion that takes place at a site. Topography and vegetation in the area will also affect the rate of erosion. Site stability has three subcategories, which are listed in the Table 5-4.

Table 5-4: Site Stability

Category	Description
Site Stable	MEC should not be exposed by natural events
Moderately Stable Site	MEC may be exposed by natural events
Site Unstable	MEC most likely will be exposed by natural events

5.3.3 Human Factors

Two categories are evaluated in the primary human risk factor. These are site activity and population.

5.3.3.1 Site Activity

The types of activities performed at a site affect the likelihood of encountering MEC. The site activity category examines whether the impact from MEC on an activity is significant, moderate, or low. Activities may be generally classified as recreational and occupational. Occupational activities include construction, archaeology, grounds keeping, manufacturing, and farming. Occupational activities are characterized by frequent site visits, stationary tasks, and possibly ground intrusion that could uncover MEC. Recreational activities include child play, picnics, short cuts, hunting, fishing, hiking, swimming, jogging, and golfing. The depth of the MEC affects the likelihood of people encountering it and is considered in the site activity category. Three depth intervals are considered. One is surface depth, which is on or protruding the ground to the top six inches of ground, another is below six inches but less than twelve inches deep, and

the third is greater than twelve inches deep. General guidelines for site activity assessment are presented in Table 5-5.

Table 5-5: Site Activity

Contact Level	Depth of MEC	Site Activities
Significant	Surface	All occupational and recreational activities
Moderate	Below surface – 12 inches	All occupational activities and recreational activities such as camping and metal detecting
Low	Below surface – 12 inches	Occupational activities
	Greater than 12 inches	All occupational and recreational activities

5.3.3.2 Population

This category refers to the number of people that potentially access Forest Park on a daily basis. The number of people accessing the site affects the likelihood of encountering MEC. A direct relationship exists between the number of people and the risk of exposure. An estimate of the number of people accessing the site on a daily basis was made using the best professional judgment based on knowledge of the type of site, land use, and site accessibility.

5.4 FOREST PARK RISK IMPACT ASSESSMENT

Each of the base factors identified above was evaluated using data collected during the EE/CA investigation and data presented in the ASR. The following sections discuss the risk evaluation by each of the primary risk factors discussed above.

5.4.1 Presence of MEC Factor

The ASR and other sources document the discovery of four Stokes mortars and one Livens Projector on five separate occasions in the Norman K. Probst Municipal Golf Course area between 1998 and 2002. In all instances the discovery was during construction activities as part of park renovations. The origin of the MEC is unknown but is likely one or more of the mock battles and military parades conducted at Forest Park between 1900 and 1950.

5.4.1.1 Type

The type of ordnance that has been discovered at Forest Park is a mortar projectile containing WP, which is designed to produce a large quantity of benign smoke when detonated. However, WP reacts violently when exposed to air, and people near munitions would be subject to blast injuries and burns if detonation occurred uncontrolled. Therefore, MEC at the AOC is type category 2, moderately severe, because an uncontrolled detonation is capable of producing major human injury from burns to people nearby.

5.4.1.2 Sensitivity

Stokes Mortars and Livens Projectors discovered at the AOC are believed to be MEC that were either used as intended and malfunctioned or unintentionally left in place. The former are fused, and the latter may or may not be fused. Because the MEC are likely fused as well as old and weathered, moving or altering the item can potentially detonate it. The MEC at the AOC is categorized in the highest sensitivity category, 3, very sensitive.

5.4.1.3 Density

The Forest Park AOC is approximately 125 acres, and five MEC discoveries have occurred. The AOC is in a highly populated urban area on land that has been developed and improved on several occasions, most recently for the extensive renovation in 2000 as part of the Forest Park Master Plan. All five discoveries appear arbitrarily distributed in the AOC (see Figure 4-1). No munitions storage, stockpiling, distribution, or impact areas have been identified at Forest Park. The discoveries have all occurred during activities not intended to locate MEC. Density is sparse, one random MEC in 25 acres.

5.4.1.4 Depth Distribution

The five MEC items discovered at Forest Park have been recovered from excavations during construction. All parts of the AOC have been walked over by countless numbers of golfers, groundskeepers, and construction workers since Forest Park was established. Park goers would have discovered MEC on the ground surface. In addition, much of the AOC has been covered with fill material borrowed from an adjacent cut area or the Grand Basin area during the renovation in 2000 (see Appendix K). Therefore, MEC that exists at the AOC is twelve or more inches below the ground surface and none on or partially exposed on the surface.

5.4.2 Site Characteristics Factor

Forest Park was established as a public park by the City of St. Louis in 1876 at the time on undeveloped farmland two miles west of the city. St. Louis has grown to completely surround the park with urban development. Forest Park is operated by the St. Louis City Department of Parks, Recreation, and Forestry, who has developed nearly all the park for public recreational use, with a small area in the southwest corner preserved as a forest. Future use is expected to continue as a public park with land uses not changing.

5.4.2.1 Site Accessibility

Access to the park is generally unrestricted to park goers. The AOC is the Norman K. Probststein Municipal Golf Course, which is open to the public. Access to the fairways is restricted to paid users and employees of the golf course. All areas of the AOC are developed for the golf course and are maintained. The AOC is generally flat and open with man-made water breaks, extensive landscaping, and roads and buildings. The site accessibility factor is limited restriction to access.

5.4.2.2 Site Stability

The climate in the St. Louis area is subject to occasional severe thunderstorms during the spring rainy season and ground freezing during the winter dry season. A storm sewer system and flood control system exists and the River de Perez was channeled underground in 1930, preventing

flooding except for extreme rainfall events in the last half century. Erosion is minimized by grounds maintenance and landscaping. MEC should not be exposed by natural events and the site stability category is stable.

5.4.3 Human Factor

Forest Park attracts more than 12 million visitors annually. Attractions at the park include the St. Louis Zoo, the St. Louis Art Museum, the Missouri History Museum, the St. Louis Science Center, and Muny Theater. Forest Park also serves as a sports center for such activities as golf, tennis, baseball, bicycling, boating, fishing, handball, ice-skating, roller blading, jogging, cricket, and rugby. Monuments, historic buildings, wildlife, waterways, and landscapes combine to form a treasured resource for the entire St. Louis area. General public activities are recreational and include the Art Museum and Grand Basin waterway in the area of Art Hill, and golfing and biking in the area of the Norman K. Probst Municipal Golf Course.

5.4.3.1 Site Activities

The activities performed at the AOC combined with the depth of the MEC determine contact level for the site activities factor. Maintenance and operation of the park facilities, including grounds keeping for Norman K. Probst Municipal Golf Course, are occupational activities. Periodic construction of park facilities is also an occupational activity. Park goers and golfers engage in recreational activities and are less likely to encounter MEC than groundskeepers or construction workers. Depth to MEC is expected to be greater than twelve inches for the entire AOC. For occupational and recreational activities at this AOC, the contact level is low.

5.4.3.2 Population

The Forest Park population typically consists of hikers, runners, golf course employees, and golfers. Forest Park is open year-round, receives more than 12 million visitors annually, and employs hundreds of people. The park is surrounded by urban land use including residential development, although no residences are present on the AOC. The population factor is hundreds of people daily every day of the year.

5.4.4 Baseline Risk Impact Assessment

The baseline risk impact assessment lists the factors described in sections 5.4.1 through 5.4.3. The baseline assessment is used as the standard to compare and assess the remedial alternatives on Table 5-6. Overall risk to humans and the environment is low based on sparse density of MEC discoveries, the depth below the ground surface it occurs, the unlikelihood that many if any still occur. The area is heavily used and has been for decades, is actively maintained for its current land use, and has been extensively renovated recently. These factors indicate that MEC that may exist has already been discovered.

5.5 RESPONSE ALTERNATIVE EVALUATION

Each response alternative is ranked using the base factors identified in section 5.2. The baseline risk impact assessment described in section 5.3 represents existing conditions. Each response alternative has been assigned an impact assessment score of “No Impact” or an alphabetical rank

from “A” to “D” relative to the baseline and other alternatives. A response alternative with a ranking of “A” has the greatest risk reduction relative to the baseline and the other alternatives. A response alternative with a ranking of “C” has the lowest risk reduction relative to the baseline and the other alternatives. The MEC risk impact assessment for each response alternative is presented in Table 5-6. The response alternatives being assessed in this EE/CA are:

- No DoD Action Indicated (NDAI)
- Institutional Controls
- Comprehensive Surface Clearance with Institutional Controls
- Comprehensive Subsurface Clearance with Institutional Controls

The response alternatives are described briefly in the following sections. More details for the alternatives are provided in Chapter 6 of this report.

Table 5-6: Risk Impact Assessment

Alternative	Presence of MEC				Site Characteristics		Human		Rank
	Type	Sensitivity	Density	Depth	Access	Stability	Activity	Population	
Baseline	2 Moderately severe	3 very sensitive	0.04 MEC per acre	Greater than 12 inches	Limited restrictions to AOC	Stable	Low contact level	Hundreds of people daily	
No DoD Action Indicated (NDAI)	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	D
Institutional Controls	No Impact	No Impact	No Impact	No Impact	C	No Impact	C	No Impact	C
Comprehensive Surface Clearance with Institutional Controls	No impact	No Impact	B	No Impact	B	No Impact	B	No Impact	B
Comprehensive Subsurface Clearance with Institutional Controls	A	A	A	A	A	No Impact	A	No Impact	A

5.5.1 No DoD Action Indicated (NDAI)

NDAI is the same as the baseline. NDAI is the condition where this EE/CA concludes that no MEC exists or that MEC that exists does not pose hazards to humans or the environment. NDAI has been assigned an overall ranking of D and offers the lowest risk reduction of all alternatives evaluated. With this alternative, no response is implemented and risk to public safety from MEC is unchanged.

5.5.2 Institutional Controls

5.4.2.1 Institutional Controls has been assigned an overall relative ranking of C. Institutional Controls are legal, physical, and educational mechanisms that protect property owners and the public from MEC hazards at a site. Effectively used, Institutional Controls prevent human exposure to MEC by restricting land use or providing a physical barrier between human receptors and the hazard, or alert people to the proper safe response if MEC is encountered. For the OERIA, the Institutional Controls alternative assumes that the mechanisms implemented would be as effective as removing the hazard, but does not consider which mechanisms are implemented. Site access characteristics and human activity base factors are affected by this alternative by restricting access to the subsurface for some activities.

5.4.2.2 During the TPP process and stakeholder interviews, it was determined that this response action would be the most acceptable action to the stakeholders. The site is an active golf course that has recently finished major renovations. There are no anticipated intrusive operations in the future other than regular course maintenance. The only time that MEC was found on site was during the renovation.

5.5.3 Comprehensive Surface Clearance with Institutional Controls

Comprehensive Surface Clearance with Institutional Controls has been assigned an overall relative ranking of B. The clearance activities may remove a MEC hazard on the surface in the AOC and lessens the presence of the MEC base factor. The Institutional Controls component of this alternative provides education/awareness information regarding the potential presence of subsurface MEC and what to do if MEC is encountered.

5.5.4 Comprehensive Subsurface Clearance with Institutional Controls

Comprehensive Subsurface Clearance with Institutional Controls has been assigned an overall relative ranking of A and offers the greatest risk reduction among the alternatives evaluated. This alternative consists of detection and investigation of all subsurface metallic anomalies within the AOC and removal of MEC items found. The limits of anomaly detection are generally four feet below ground surface. MEC may exist at depths greater than 4 feet due to human activities either intentionally, such as a disposal method, or unintentionally, such as land development where fill material was added. Hazards from MEC that exists more than four feet below ground surface would be mitigated by Institutional Controls. The MEC presence factor is therefore impacted, removing explosive risk by removing the source. The AOC would be restored and site characteristics and human factors would be unchanged. Human activity base factor is affected by Institutional Controls that restrict access to soil greater than four feet that may contain MEC.

5.6 CONCLUSION

The response alternatives evaluated in order of reducing MEC hazards are:

1. Comprehensive Subsurface Clearance with Institutional Controls
2. Comprehensive Surface Clearance with Institutional Controls

3. Institutional Controls
4. NDAI

This conclusion is based on the ability of each alternative to mitigate hazards to park visitors and employees from existing MEC at Forest Park and is relative to the other alternatives.

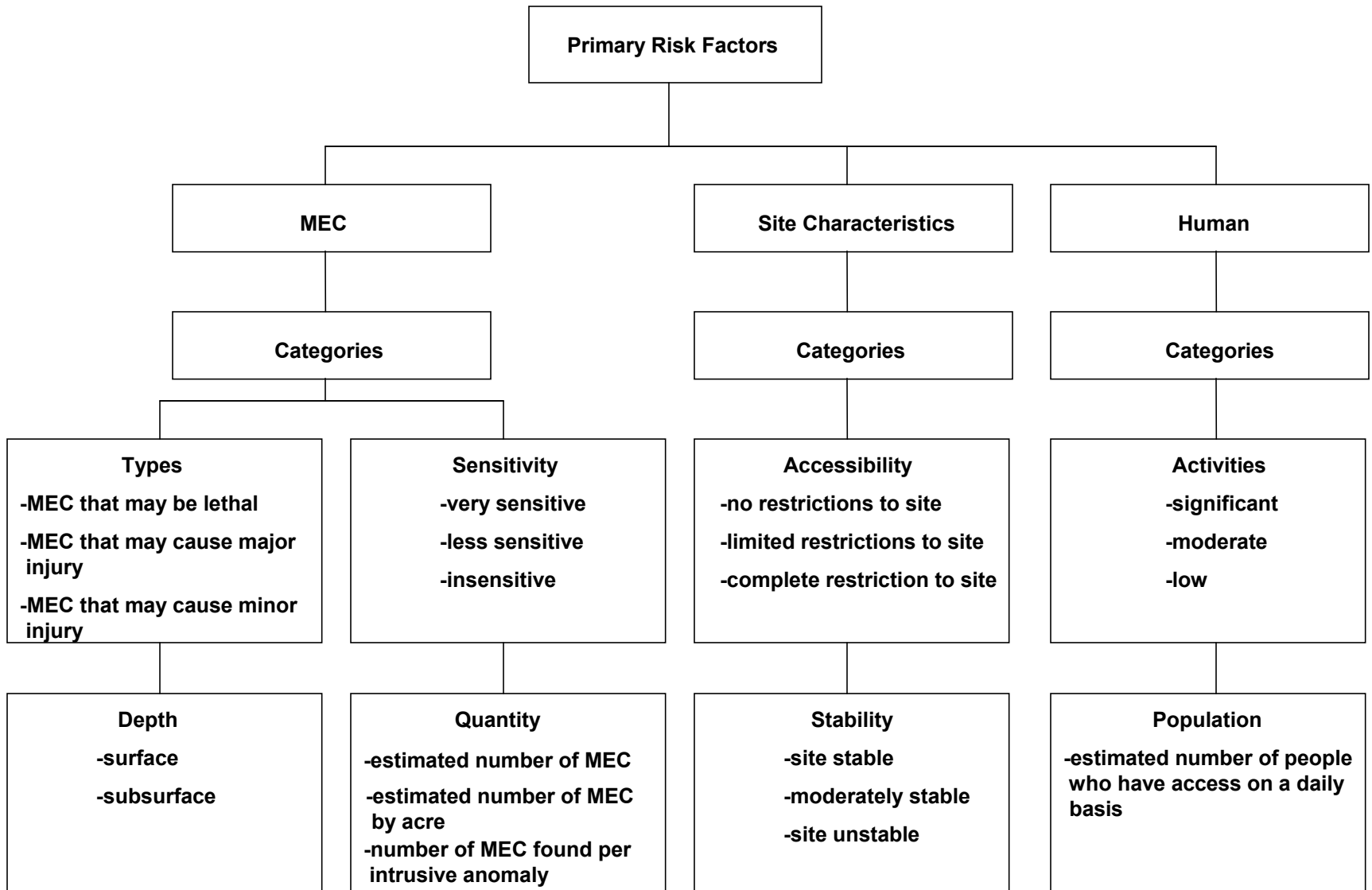


Figure 5-1: OERIA Risk Factors

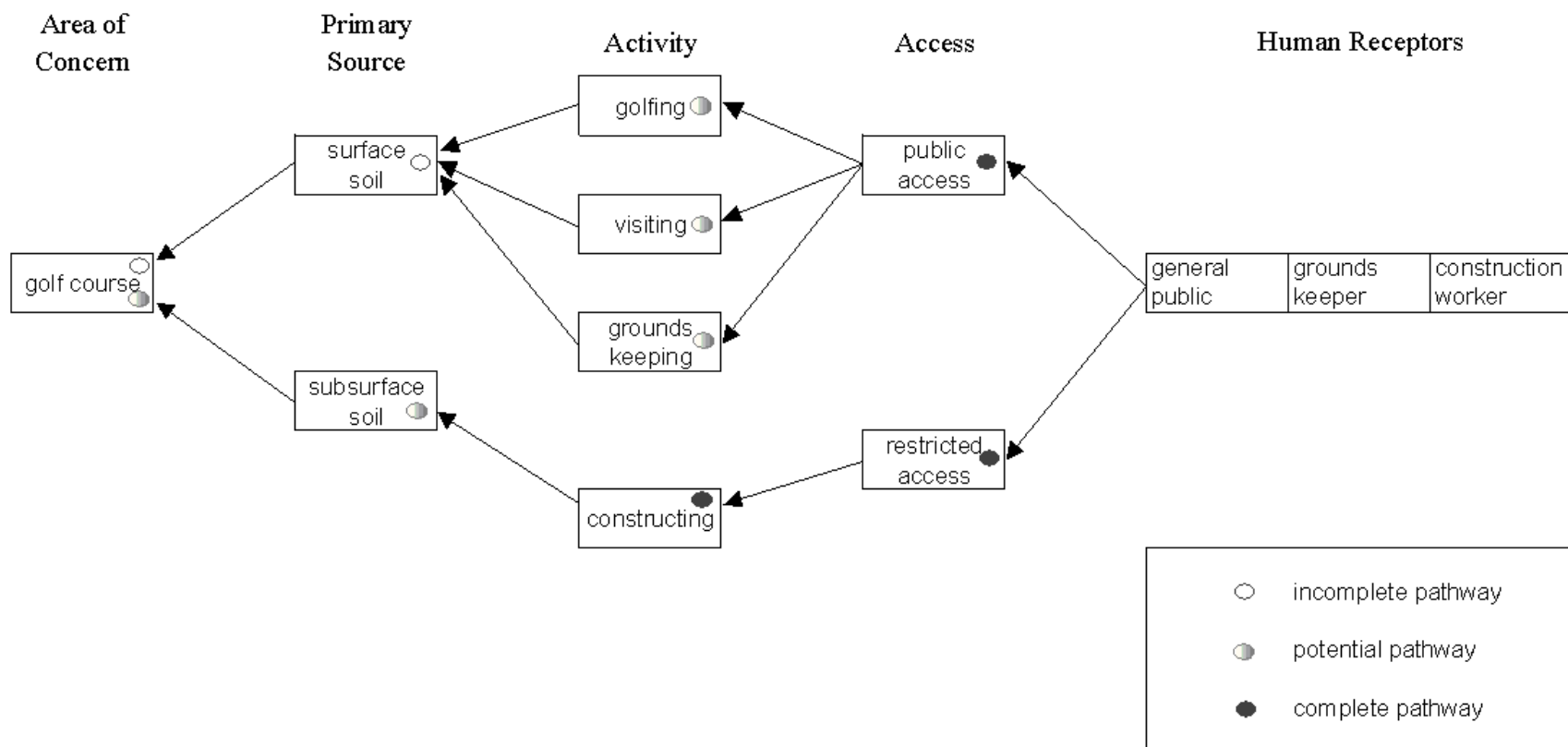


FIGURE 5-2
CONCEPTUAL SITE MODEL
 Forest Park EE/CA
 St. Louis, MO

6 RESPONSE ALTERNATIVES EVALUATION

6.1 INTRODUCTION

6.1.1 In this chapter, the response alternatives selected for the Forest Park site are identified and analyzed according to the evaluation criteria of effectiveness, implementability, and cost.

6.1.2 The four response alternatives were identified based on the nature, extent, and analysis of MEC occurrence at the site, intended future land use, and explosive hazard reduction for members of the public and workers at Forest Park. Response alternatives for Forest Park can be categorized as either non-removal based or removal based.

Non-removal based alternatives are:

- NDAI
- Institutional Controls

Removal based alternatives are:

- Comprehensive Surface Clearance with Institutional Controls
- Comprehensive Subsurface Clearance with Institutional Controls

6.2 ALTERNATIVES SCREENING PROCESS DESCRIPTION

Each of the above response alternatives was screened according to the evaluation criteria categories of effectiveness, implementability, and cost. These categories are described in further detail below.

6.2.1 Effectiveness

This criterion applies to the capability of a response alternative to reduce explosive safety risk to members of the public, Forest Park workers, and the environment. Specific factors evaluated as part of the effectiveness criterion are described below.

6.2.1.1 Overall protection of human health and the environment

This factor addresses explosive safety risk that exists as a result of MEC being present at the site and assesses the ability of the response action alternative to mitigate that risk.

6.2.1.2 Achievement of response action objectives

This factor addresses the objectives of the response action as determined in the TPP Process and whether those objectives are achieved. Response action objectives identified in the TPP Process include:

- Characterization of the nature, location, and concentration of MEC including a description of the MEC related problems affecting human use of the site

- Identify and analyze reasonable risk management alternatives
- Recommend a proposed alternative for this particular site
- Seek public comment and participation
- Provide a convenient record of the process for use in final decision making and judicial review, if necessary

6.2.2 Implementability

This criterion addresses whether or not the response alternative can be implemented with regard to technical and schedule constraints that may exist. Additionally, public and regulatory/administrative acceptance are specific factors that are evaluated as part of the implementability criteria. Specific factors evaluated as part of the implementability criterion are described below.

6.2.2.1 Technical feasibility

This factor addresses the availability of existing technologies required to complete the response action and meet response action objectives. If required technology does not currently exist or effectiveness of the response action cannot be monitored, the ability to undertake future risk-reduction actions should be considered in this analysis.

6.2.2.2 Schedule requirements

This factor analyzes the availability of equipment and personnel required to complete the response action. Additionally, impacts to existing land use are evaluated with regard to the response action.

6.2.2.3 Public and regulatory/administrative acceptance of alternative

This factor evaluates the concerns and level of acceptance by members of the public with regard to the response action. Concerns and issues that the EPA, Missouri Department of Natural Resources, and St. Louis/Forest Park entities may have regarding the response action are also addressed in this analysis.

6.2.3 Cost

This factor analyzes the funding required to complete the response action. Costs for each alternative are based on detailed cost estimates, which are included as Appendix E.

6.3 SCREENING OF RESPONSE ALTERNATIVES

6.3.1 Alternative 1, No DoD Action Indicated (NDAI)

The NDAI alternative is included for evaluation to provide a baseline for comparison to the other response action alternatives. No non-removal or removal activities are included in this alternative. As a result, no explosive risk reduction is expected to occur if this alternative is implemented. The NDAI alternative is most appropriate for sites where MEC has not been found and is not expected to exist based on evidence, or for sites where the occurrence of MEC

poses a minimal threat (e.g., sites with extremely limited access, sites with MEC at significant depth).

6.3.1.1 Effectiveness

This alternative is not considered effective with regard to overall protection of human health and the environment and achievement of response action objectives.

6.3.1.1.1 Overall protection of human health and the environment

The NDAI alternative results in no reduction of explosive safety risk to members of the public or workers conducting intrusive activities on the site. The potential MEC that exists will continue to remain in place and no reduction of risk will occur. Additionally, individuals most likely to encounter MEC will not be made aware of the potential to encounter MEC and how to handle such an encounter.

6.3.1.1.2 Achievement of response action objectives

This alternative does not achieve the response action objectives outlined above in Section 6.2.1.2. As MEC will remain in place and no institutional controls will be implemented to reduce explosive safety risk, this alternative does not achieve response action objectives.

6.3.1.2 Implementability

6.3.1.2.1 Technical feasibility

This alternative involves no action and therefore, technical feasibility is not applicable.

6.3.1.2.2 Schedule requirements

This alternative involves no action and therefore, the availability of personnel and equipment are not required and impacts to existing land use would not occur.

6.3.1.2.3 Public and regulatory/administrative acceptance of alternative

Implementation of this alternative would result in no changes to existing access to Forest Park for members of the public. However, the existence of MEC documented on the site, and no mitigation of the explosive risk are a potential concern for members of the public. Regulatory agencies and city entities are aware of the potential presence of MEC within the AOC. Leaving MEC in place and taking no action to mitigate the explosive safety risk that exists would presumably be unacceptable to regulatory agencies and city entities.

6.3.1.3 Cost

There is no cost associated with this alternative.

6.3.2 Alternative 2, Institutional Controls

A combination of MEC education/awareness materials and an MOA between the City of St. Louis and USACE are included in the Institutional Controls alternative. Although Institutional Controls as a category can include access controls such as fences and administrative limitations such as covenants and deed restrictions, these restrictions are not included as part of Alternative 2 because of Forest Park's current land use as a city park and the expected use of the property as a public park in the future. A more detailed description of Alternative 2 is provided in Appendix E.

6.3.2.1 Effectiveness

6.3.2.1.1 Overall protection of human health and the environment

This alternative results in some reduction of explosive safety risk to members of the public or intrusive workers conducting activities on the site. Although the potential MEC that exists will continue to remain in place, Spanish and English educational/awareness materials will notify site workers of the potential for MEC to be present and what to do if MEC is encountered. An MOA between the City of St. Louis and USACE will insure that educational/awareness materials are provided to individuals most likely to encounter MEC. The Construction Division of the City of St. Louis will be responsible for distribution of the MEC educational/awareness materials. This city office approves all construction activities within Forest Park.

6.3.2.1.2 Achievement of response action objectives

Response action objectives include minimizing the potential for members of the public and workers on site to be injured or killed as a result of encountering MEC. Education and awareness have been shown to be effective at reducing explosive safety risks to the public and workers at other sites. Establishment of an MOA will insure that individuals most likely to encounter MEC are aware of the potential and what to do in such an instance.

6.3.2.2 Implementability

6.3.2.2.1 Technical feasibility

This alternative is technically feasible. Production of educational/awareness materials and development of an MOA can be accomplished with existing and readily available technology.

6.3.2.2.2 Schedule requirements

This alternative requires minimal commitment of personnel and equipment to conduct the response action. Additionally, ongoing and future uses of Forest Park would not be impacted as a result of implementation of this response action. Future construction activities within the park would not be restricted, but would require that all individuals performing ground intrusive work receive information regarding the potential for encountering MEC.

6.3.2.2.3 Public and regulatory/administrative acceptance of alternative

Implementation of this alternative would result in no changes to existing access to Forest Park for members of the public. However, the continued existence of MEC documented on the site is a potential concern for members of the public. This alternative does not recommend providing educational/awareness materials to the general public because they are not expected to conduct intrusive activities that could result in contact with MEC. A subset of the public, workers who conduct intrusive activities, would be provided these materials. This would presumably be met with approval by workers conducting intrusive activities, as they would have information available to assist them in making informed decisions if they decide to work at the site. Regulatory agencies and city entities are aware of the potential presence of MEC within the AOC. Leaving MEC in place may not be viewed as a permanent solution and may be deemed unacceptable. However, the significant disruption of traffic and public access that would be required to remove MEC would also have significant impacts on city entities in particular. These impacts are discussed further in the evaluations of Alternatives 3 and 4 below.

6.3.2.3 Cost

The cost associated with this alternative is approximately \$15,000 for the first year and \$6,000 for subsequent years. First year costs include task management and the development of bilingual educational/awareness materials regarding MEC. These costs are one time costs and would not exist for out years. Costs after year one would only include a production run of the informational materials and a site visit to distribute the materials. Further details regarding the costs of Alternative 2 are included in Appendix E.

6.3.3 Alternative 3, Comprehensive Surface Clearance with Institutional Controls

Comprehensive surface clearance would require UXO specialists, who are trained in MEC recognition, and safety and disposal techniques, to cover 100% of the AOC using a magnetometer to assist in detection of surface metallic anomalies. A magnetometer is an instrument that measures the variations in the earth's magnetic field in order to locate metal objects on or below the ground surface. The primary method of location of MEC on the surface would be visual. A magnetometer would be used in areas where the ground surface was obscured, such as by leaf litter or bushes. Only MEC on or protruding from the ground surface would be removed and disposed. If a magnetometer indicated a metallic anomaly but nothing was visible at the ground surface, the anomaly would be left in place. After completion of the Comprehensive Surface Clearance, a combination of MEC education/awareness materials and an MOA between the City of St. Louis and USACE would serve as Institutional Controls to minimize any residual explosive risk. Although Institutional Controls as a category can include access controls such as fences and administrative limitations such as covenants and deed restrictions, these restrictions are not included as part of Alternative 3 because of Forest Park's current land use as a city park and the expected use of the property as a public park in the future.

This alternative would minimize the risk of incidental contact with MEC to members of the public accessing Forest Park and to workers conducting ground intrusive activities. Due to Forest Park's mostly open space, the fact that the park has been open to the public for more than 100 years without documentation of any MEC surface discoveries, and the use of the park by millions of people each year, the probability of locating significant amounts of MEC on the surface is low. Although no visual inspection of the entire AOC has been completed, the low probability of encountering surface MEC discussed in Chapter 5 precludes the requirement for conducting a visual inspection. MEC trained individuals have been on the site during construction support activities and during responses to MEC discoveries during construction. Institutional Controls described above would ensure that workers conducting ground intrusive activities are aware of the potential for encountering MEC not removed as part of the Comprehensive Surface Clearance. A more detailed description of Alternative 3 is provided in Appendix E.

6.3.3.1 Effectiveness

6.3.3.1.1 Overall protection of human health and the environment

This alternative potentially results in significant reduction of explosive safety risk to members of the public accessing Forest Park. The public is most likely to encounter MEC that is present on the ground surface. This alternative results in some reduction of explosive safety risk to workers conducting ground intrusive activities on the site. Although the potential MEC that exists below

the ground surface will continue to remain in place, Spanish and English educational/awareness materials will notify site workers of the potential for MEC to be present and what to do if MEC is encountered. An MOA between the City of St. Louis and USACE will insure that educational/awareness materials are provided to individuals most likely to encounter MEC. Previous MEC finds within Forest Park have all occurred during construction that involved ground intrusive activities. Although the probability of encountering MEC on the surface is extremely low, this alternative is included in the evaluation because of the slight potential for encountering surface MEC. If an item were found and removed, it would result in a reduction of explosive risk.

6.3.3.1.2 Achievement of response action objectives

As discussed previously, the probability of encountering MEC on the surface is low. Comprehensive surface clearance is generally considered appropriate in areas where surface MEC has been confirmed or where surface inspections have not occurred. A reduction in explosive risk to members of the public and workers conducting ground intrusive activities would potentially occur, both through the implementation of the surface clearance and subsequent Institutional Controls.

6.3.3.2 Implementability

6.3.3.2.1 Technical feasibility

Implementation of this alternative is technically feasible. Conducting a Comprehensive Surface Clearance with Institutional Controls requires equipment and personnel that are readily available and proven.

6.3.3.2.2 Schedule requirements

Implementation of this alternative is expected to take 12.5 weeks of actual fieldwork. Preparation of documents and project planning would require an additional 3 to 6 months. Equipment and personnel are available to conduct this response action. Impacts to existing land use and scheduled events with implementation of this alternative could be substantial. Road closures and restriction of public access to areas of Forest Park would be expected to occur for at least a portion of the implementation period. Performance of this alternative would be expected to occur in the spring, summer, or fall months, which are also the months with the most intense public usage of Forest Park. The comprehensive surface clearance would presumably not be conducted during the winter months because of the uncertainty associated with snowfall in the St. Louis area. Implementation of the subsequent Institutional Controls would require minimal commitment of personnel and equipment. However, the Institutional Controls component of this alternative would be an ongoing requirement.

6.3.3.2.3 Public and regulatory/administrative acceptance of alternative

Implementation of this alternative could result in substantial changes to existing access to Forest Park for members of the public during the 12.5-week comprehensive surface clearance. Additionally, some residents in close proximity to Forest Park may be required to temporarily vacate their homes if this alternative is selected. These temporary relocations would be required in the event MEC was located in close proximity to homes bordering Forest Park and during demolition operations. The continued existence of subsurface MEC documented on the site is a potential concern for members of the public and workers conducting ground intrusive activities.

However, the Institutional Controls component of this alternative ensures that those most likely to encounter residual MEC are aware of its potential presence below the ground surface. Regulatory agencies and city entities are aware of the potential presence of MEC within the AOC. Leaving MEC in place below the ground surface may not be viewed as a permanent solution and may be deemed unacceptable. However, the significant disruption of traffic and public access that would be required to remove MEC from the surface would also have significant impacts on city entities in particular. City entities have expressed concerns with respect to closure or restriction of the public's movement in Forest Park. The golf course recently underwent a multi-million dollar renovation, and any disruption in the use of the golf course could result in serious financial implications. The St. Louis Art Museum, which is located in close proximity to the site, could also be impacted negatively by implementation of this alternative. Another negative impact regarding this alternative is significant disruption of traffic patterns within and around Forest Park. Forest Park serves as a major traffic thoroughfare for thousands of residents each day. Restrictions on traffic through the park during the comprehensive surface clearance could result in substantial traffic control problems in and around Forest Park.

6.3.3.3 Cost

The cost associated with the comprehensive surface component of this alternative is approximately \$600,000. This cost includes a seven-person UXO team and oversight on site for 12.5 weeks. Hotel and per diem costs are also included. The cost associated with the Institutional Controls component of this alternative is approximately \$15,000 for the first year and \$6,000 for subsequent years. First year costs include task management and the development of bilingual educational/awareness materials regarding MEC. These costs are one time costs and would not exist for out years. Costs after year one would only include a production run of the informational materials and a site visit to distribute the materials. Further details regarding the costs of Alternative 3 are included in Appendix E.

6.3.4 Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls

Comprehensive subsurface clearance would require UXO specialists, who are trained in MEC recognition, safety, and disposal techniques, to cover 100% of the AOC using a magnetometer to detect subsurface metallic anomalies. Each metallic anomaly detected would need to be investigated. Digital geophysical mapping (DGM) is an additional technique that could be employed to locate subsurface anomalies at the Forest Park AOC. DGM is a technique used during MEC clearance actions that provides sensor data that is digitally recorded and geo-referenced. This digital record is then used to determine which anomalies exhibit characteristics of MEC expected at the site. Anomalies exhibiting the signature of MEC expected at the site are subsequently investigated by UXO specialists. In this instance, only anomalies exhibiting the characteristics of MEC expected at the site would be investigated. Implementation of a magnetometer assisted or DGM based clearance would also remove any MEC located on the ground surface. If MEC were detected during the investigation, the item would be handled and disposed of by St. Louis Police Department Bomb and Arson Squad detectives. This alternative would allow for the removal of any MEC reasonably possible to detect and would significantly reduce the explosives risk to members of the public and workers conducting intrusive activities within Forest Park. Although no technology currently exists that will detect 100% of all

subsurface metallic anomalies to all depths, existing technologies are very effective at detecting anomalies at shallow depths. Although some MEC items could potentially remain in place after performance of this response action, subsurface clearance has been shown to contribute significantly to a reduction in explosive safety risk at other sites. After completion of the Comprehensive Subsurface Clearance, a combination of MEC education/awareness materials and an MOA between the City of St. Louis and USACE would serve as Institutional Controls to minimize any residual explosive risk. Although Institutional Controls as a category can include access controls such as fences and administrative limitations such as covenants and deed restrictions, these restrictions are not included as part of Alternative 4 because of Forest Park's current land use as a city park and the expected use of the property as a public park in the future. A more detailed description of Alternative 4 is provided in Appendix E.

Effectiveness

6.3.4.1.1 Overall protection of human health and the environment

This alternative would result in the significant reduction of explosive safety risk to members of the public and ground intrusive workers accessing Forest Park. Removal of a substantial amount of MEC on the site would lower the probability of a worker or member of the public encountering MEC. Previous documented MEC finds within Forest Park have all occurred during construction that involved ground intrusive activities. Although the potential exists for some undetected MEC to remain in place, Spanish and English educational/awareness materials will notify site workers of the potential for MEC to be present and what to do if MEC is encountered. An MOA between the City of St. Louis and USACE will insure that educational/awareness materials are provided to individuals most likely to encounter MEC.

6.3.4.1.2 Achievement of response action objectives

This alternative significantly limits the potential of future direct contact with MEC, with a corresponding reduction in the potential for injury or death.

6.3.4.2 Implementability

6.3.4.2.1 Technical feasibility

Implementation of this alternative is technically feasible. Conducting a Comprehensive Subsurface Clearance with Institutional Controls requires equipment and personnel that are readily available and proven. Technical constraints with regard to this alternative include the presence of significant amounts of subsurface metallic construction debris associated with the 1904 World's Fair. This metallic debris could serve to shield MEC items from detection and may result in a significant amount of excavations that yield no reduction in explosive risk.

6.3.4.2.2 Schedule requirements

Implementation of this alternative is expected to take 17.5 weeks of actual fieldwork. Preparation of documents and project planning would require an additional 3 to 6 months. Additional time of 1 month would be required to restore the area to its previous condition. Equipment and personnel are available to conduct this response action. Impacts to existing land use and scheduled events with implementation of this alternative could be substantial. Road closures and restriction of public access to areas of Forest Park would be expected to occur for at least a portion of the implementation period. Performance of this alternative would be expected

to occur in the spring, summer, or fall months, which are also the months with the most intense public usage of Forest Park. The comprehensive subsurface clearance would presumably not be conducted during the winter months because of the uncertainty associated with snowfall in the St. Louis area. Implementation of the subsequent Institutional Controls would require minimal commitment of personnel and equipment. However, the Institutional Controls component of this alternative would be an ongoing requirement.

6.3.4.2.3 Public and regulatory/administrative acceptance of alternative

Implementation of this alternative could result in substantial changes to existing access to Forest Park for members of the public during the 17.5-week comprehensive subsurface clearance. Additionally, some residents in close proximity to Forest Park may be required to temporarily vacate their homes if this alternative is selected. These temporary relocations would be required during investigation of some subsurface anomalies, in the event MEC was located in close proximity to homes bordering Forest Park, and during demolition operations. However, the continued existence of MEC documented on the site is a potential concern for members of the public. A subset of the public, workers who conduct intrusive activities, would presumably be in favor of this alternative as it provides substantial reduction in explosive risk for their activities. Additionally, the Institutional Controls component of this alternative ensures that those most likely to encounter undetected MEC are aware of its potential presence below the ground surface. Regulatory agencies and city entities are aware of the potential presence of MEC within the AOC. Removal of all detectable MEC and the corresponding reduction in explosive risk would presumably be the preferential alternative. However, the significant disruption of traffic and public access that would be required to remove MEC from the subsurface would also have significant impacts on city entities in particular. City entities have expressed concerns with respect to closure or restriction of the public's movement in Forest Park. The golf course recently underwent a multi-million dollar renovation, and any disruption in the use of the golf course could result in serious financial implications. The St. Louis Art Museum, which is located in close proximity to the site, could also be impacted negatively by implementation of this alternative. The final negative impact regarding this alternative is significant disruption of traffic patterns within and around Forest Park. Forest Park serves as a major traffic thoroughfare for thousands of residents each day. Restrictions on traffic through the park during the comprehensive subsurface clearance could result in substantial traffic control problems in and around Forest Park.

6.3.4.3 Cost

The cost associated with the comprehensive subsurface clearance component of this alternative is approximately \$2,200,000 for a magnetometer clearance and approximately \$960,000 for a clearance conducted using DGM. The cost associated with the Institutional Controls component of this alternative is approximately \$15,000 for the first year and \$6,000 for subsequent years. First year costs include task management and the development of bilingual educational/awareness materials regarding MEC. These costs are one time costs and would not exist for out years. Costs after year one would only include a production run of the informational materials and a site visit to distribute the materials. Further details regarding the costs of Alternative 4 are included in Appendix E.

6.4 COMPARATIVE ANALYSIS OF RESPONSE ACTION ALTERNATIVES

The following sections differ from the previous evaluation of the response action alternatives in that each response action will be evaluated in relation to the other alternatives. The purpose of this analysis is to identify the advantages and disadvantages of each alternative relative to the others. Each alternative is compared with the other alternatives with regard to effectiveness, implementability, and cost. Alternative 1, NDAI, is included in the analysis, but is not considered an acceptable MEC response action. A ranking system is explained and displayed graphically in the following sections to compare the alternatives and to assist in the selection of the recommended response action alternative(s).

6.4.1 Effectiveness

The two factors considered in the effectiveness criteria are overall protection of human health and the environment, and achievement of response action objectives. As presented in Table 5-6: OERIA Risk Evaluation, the alternatives that are most effective at reducing explosive risk are assigned the highest scores for effectiveness. The response action alternatives are assigned a ranking of 1 to 3 relative to the other response action alternatives, 1 being the most effective and 3 being the least effective. After this analysis is complete, alternatives are ranked as to their effectiveness. The results of this analysis are displayed in Table 6-1. Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, has the most favorable score for effectiveness. Alternative 3, Comprehensive Surface Clearance with Institutional Controls, is considered the second most effective alternative. Alternative 1, Institutional Controls, is considered the least effective. The evaluation factors are discussed in further detail below.

Table 6-1: Effectiveness Criteria Evaluation

	Alternative 1, No DoD Action Indicated (NDAI)	Alternative 2, Institutional Controls	Alternative 3, Comprehensive Surface Clearance with Institutional Controls	Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls
Overall protection of human health and the environment	NA	3	2	1
Achievement of response action objectives	NA	3	2	1
Total	NA	6	4	2
Rank	NC	3	2	1

NA = Not Applicable NC = Not Considered

6.4.1.1 Overall protection of human health and the environment

6.4.1.1.1 Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, was determined to provide the most overall protection of human health and the environment. Implementing this alternative is expected to provide the maximum removal of MEC items from the site, with a corresponding reduction in explosive risk to the public and intrusive workers.

6.4.1.1.2 Alternative 3, Comprehensive Surface Clearance with Institutional Controls, was determined to provide more overall protection of human health and the environment than Alternative 2, but less than Alternative 4. Although this alternative would remove any MEC items on the ground surface, the probability of finding MEC on the ground surface is low. MEC education/awareness training would be provided for ground intrusive workers. These are the individuals most likely to encounter MEC remaining beneath the ground surface

6.4.1.1.3 Alternative 2, Institutional Controls, was determined to provide the least overall protection of human health and the environment. MEC would potentially remain in place below and at the ground surface. This alternative is considered the least effective with regard to overall protection of human health and the environment.

6.4.1.2 Achievement of response action objectives

The alternative rankings for this factor are the same as those discussed above for reasons similar to those outlined in the above sections.

6.4.2 Implementability

The three factors considered for the implementability criteria are technical feasibility, schedule requirements, and public and regulatory/administrative acceptance of the alternative. The results of this analysis are displayed in the Table 6-2. Alternative 2, Institutional Controls, has the most favorable score for implementability. Alternative 3, Comprehensive Surface Clearance with Institutional Controls, is ranked second for this criterion, and Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, is considered the least implementable alternative. The evaluation factors are discussed in further detail below.

Table 6-2: Implementability Criteria Evaluation

	Alternative 1, No DoD Action Indicated (NDAI)	Alternative 2, Institutional Controls	Alternative 3, Comprehensive Surface Clearance with Institutional Controls	Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls
Technical feasibility	NA	1	2	3
Schedule requirements	NA	1	2	3
Public and Regulatory/ Administrative	NA	1	2	3

	Alternative 1, No DoD Action Indicated (NDAI)	Alternative 2, Institutional Controls	Alternative 3, Comprehensive Surface Clearance with Institutional Controls	Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls
acceptance				
Total	NA	3	6	9
Rank	NC	1	2	3

NA = Not Applicable NC = Not Considered

6.4.2.1 Technical feasibility

6.4.2.1.1 Alternative 2, Institutional Controls, was determined to be the most technically feasible alternative. Extremely limited equipment and personnel are required for this response action to be conducted.

6.4.2.1.2 Alternative 3, Comprehensive Surface Clearance with Institutional Controls, was determined to be the second most technically feasible alternative. This alternative is technically more difficult to implement than Institutional Controls alone.

6.4.2.1.3 Alternative 4, Comprehensive Subsurface Clearance, was determined to be the least technically feasible alternative. This alternative is considerably more difficult technically than the other alternatives.

6.4.2.2 Schedule requirements

6.4.2.2.1 Alternative 2, Institutional Controls, was determined to have the least impact from schedule requirements. Equipment and personnel required to implement this alternative would be available and Institutional Controls would not impact park access or scheduled events.

6.4.2.2.2 Alternative 3, Comprehensive Surface Clearance with Institutional Controls, was ranked as the second most implementable action with regard to schedule requirements. Equipment and personnel could be made available to conduct this action, but impacts to park access and scheduled events could occur during the 12.5-week implementation period.

6.4.2.2.3 Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, was ranked as the least implementable action with regard to schedule requirements. Equipment and personnel could be made available to conduct this action, but substantial impacts to park access and scheduled events could occur during the 17.5-week implementation period.

6.4.2.3 Public and regulatory/administrative acceptance of alternative

6.4.2.3.1 Alternative 2, Institutional Controls, was determined to be most acceptable with regard to the public, regulatory agencies, and St. Louis City administration. Particular weight

was given to the lack of restrictions on public access and overall lack of disruption to city entities associated with this alternative. Based on experience at other MEC sites, regulatory agencies generally prefer alternatives that remove MEC from the site.

6.4.2.3.2 Alternative 3, Comprehensive Surface Clearance with Institutional Controls, was ranked as the second most acceptable action with regard to the public, regulatory agencies, and St. Louis City administration. Although impacts to park access, traffic, and scheduled events could occur during the 12.5-week clearance implementation period, the implementation period of this action is less than that of Alternative 4. From a risk reduction standpoint, regulatory agencies could presumably prefer this alternative to Alternative 2.

6.4.2.3.3 Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, was ranked as the least acceptable action with regard to the public, regulatory agencies, and St. Louis City administration. Impacts to park access, traffic, and scheduled events could be substantial during the 17.5-week clearance implementation period. From a risk reduction standpoint, regulatory agencies could presumably prefer this alternative to Alternatives 2 and 3.

6.4.3 Cost

The results of the cost analysis are displayed in the Table 6-3. Alternative 2, Institutional Controls, has the most favorable score for cost. Alternative 3, Comprehensive Surface Clearance with Institutional Controls, is ranked second for this criterion, and Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, is ranked last. The evaluation is discussed in further detail below.

Table 6-3: Cost Criteria Evaluation

	Alternative 1, No DoD Action Indicated (NDAI)	Alternative 2, Institutional Controls	Alternative 3, Comprehensive Surface Clearance with Institutional Controls	Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls
Total	NA	1	2	3
Rank	NC	1	2	3

NA = Not Applicable NC = Not Considered

6.4.3.1 Cost evaluation

6.4.3.1.1 Alternative 2, Institutional Controls, was determined to be the least costly alternative. Initial costs for this alternative would include development and production of MEC educational/awareness materials and a site visit to distribute them. Subsequent years would only require production of the materials and a site visit to distribute them.

6.4.3.1.2 Alternative 3, Comprehensive Surface Clearance with Institutional Controls, was determined to be the second least costly alternative. A comprehensive surface clearance with institutional controls has higher costs than implementation of institutional controls alone, but lower costs than a comprehensive subsurface clearance with institutional controls.

6.4.3.1.3 Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, was determined to be the most costly alternative.

6.5 SUMMARY

The results of the comparative analysis of alternatives for effectiveness, implementability, and cost were combined to determine the preferential scores of the alternatives. The lowest score indicates the most preferred alternative, the second lowest score indicates the second ranked in terms of preference, and the highest score indicates the least preferred alternative. It should be noted that effectiveness, implementability, and cost were each given equal weight in this analysis. The preferential scores for the alternatives are displayed in the Table 6-4. Alternative 2 was determined to be the preferred alternative based on this analysis. Alternatives 3 and 4 were ranked equally as lesser-preferred alternatives.

Table 6-4: Preferential Scoring of Alternatives

	Alternative 1, No DoD Action Indicated (NDAI)	Alternative 2, Institutional Controls	Alternative 3, Comprehensive Surface Clearance with Institutional Controls	Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls
Effectiveness	NA	3	2	1
Implementability	NA	1	2	3
Cost	NA	1	2	3
Total	NA	5	6	7
Rank	NC	1	2	2

NA = Not Applicable

NC = Not Considered

7 INSTITUTIONAL CONTROL PLAN

7.1 GENERAL DESCRIPTION OF SITE BOUNDARIES

The Forest Park AOC encompasses the Lower 9 holes of the Norman K. Probst Municipal Golf Course and the Art Hill area. Lindell Boulevard borders the northern part of the Lower 9, Lagoon Drive and Fine Arts Drive form the southwest boundary, and a line between the History Museum and the Muny forms the southeast boundary. The Dwight Davis Tennis Courts, Post Dispatch Lake, Boat House, and Upper 9 of the golf course are not included.

7.2 SPECIFIC INSTITUTIONAL CONTROLS

7.2.1 The Institutional Controls program for Forest Park includes three controls that are designed to minimize the potential for members of the public and workers on site to be injured or killed as a result of encountering MEC. These are:

- Zoning and Planning Controls
- Education and Notification Controls
- Annual Site Visit

7.2.2 No engineering controls such as fences or signs are planned. Much of the site has engineering controls currently in place in the form of soil and pavement cover.

7.2.3 An MOA will be prepared between USACE and the City of St. Louis that identifies the Institutional Controls and details such as administration, inspection, and enforcement of the program.

7.3 RESIDUAL RISK REDUCTION

The residual risk is the hazard that exists from encountering MEC that may exist at the site and subsequent actions that may cause harm. The three control's ability to reduce residual risk is discussed individually in the following sections.

7.3.1 Zoning and Planning Controls Risk Reduction

Zoning and planning controls are governmental controls that will add notice of potential MEC hazard to the Forest Park Master Plan. Incorporating a notice of potential MEC into the Forest Park Master Plan will alerts planners to potential hazards that may exist at the site. As the Master Plan is implemented, planners can account for the hazard and adjust activities as necessary to ensure public safety.

Forest Park is currently zoned recreational by the city zoning department.

7.3.2 Education and Notification Controls

7.3.2.1 Education and notification controls include producing and distributing an educational/awareness pamphlet that describes the types of MEC found at Forest Park and details the actions to take upon discovering them. Recognizing the hazard is essential for implementing appropriate responses to contain and dispose of MEC. Distinguishing between MEC and other debris that may be encountered at Forest Park will ensure that authorities are notified and actions can be taken to dispose of the MEC without harm to anyone involved.

7.3.2.2 The pamphlets will be distributed to any person, company, or agency planning to work within the AOC. Distribution to the public-at-large is unnecessary because under normal use conditions MEC is not expected to be encountered. MEC that may exist is buried as a result of the construction of the golf course and other land uses such as pavement and landscaping. However, the pamphlet will be available to anyone upon request.

7.3.3 Annual Site Visit

The site will be subject to review by the DoD in accordance with the FUDS program to monitor the effectiveness of the Institutional Controls program. Consequently, every year, USACE, Kansas City District, will make a visit to the site to ensure that educational/notification and zoning controls are still in place and effective. If the Institutional Controls are determined to be ineffective or not useful, changes can be made. The site visit program will continue indefinitely until it is determined to be unnecessary. The recurrence interval is every year but may be changed if necessary.

7.4 AGENCIES INVOLVED WITH INSTITUTIONAL CONTROLS

The landowner is the principal agency for effective Institutional Controls. The City of St. Louis owns the entire Forest Park area, including the AOC. As the former owner of the Forest Park Recreation Camp, the DoD has the responsibility to protect the public from MEC hazards for current and future land use. The City of St. Louis will implement the modifications to the Forest Park Master Plan. USACE will reproduce the MEC pamphlets and provide them to the City of St. Louis, Construction Division, for distribution. The five-year reviews will be programmed and budgeted by USACE and performed in cooperation with the St. Louis Department of Parks, Recreation, and Forestry.

7.5 INSTITUTIONAL CONTROLS FUNDING

7.5.1 Short-Term Costs

Short-term costs for implementing Institutional Controls are already programmed into this EE/CA. These costs are summarized in Appendix C of this EE/CA. Short-term costs include the design and production of the MEC pamphlets, coordination and approval of the MOA, solicitation of public participation in the EE/CA process, and site visits to distribute the pamphlets.

7.5.2 Long-Term Costs

Long-term costs include the costs for reproducing fact sheets and performing five-year reviews. These costs are summarized in Appendix C of this EE/CA.

7.5.3 Funding Sources

The DERA account funds the FUDS program. It will provide funding for future five-year reviews. The funding is programmed annually and funded with congressional appropriations. Programming is also reviewed annually and can be modified if necessary.

7.6 REQUIREMENTS AND SCHEDULE

The EE/CA schedule includes the tasks of designing and producing an MEC educational/awareness pamphlet, as well as establishing an MOA between the City of St. Louis and USACE by 30 September 2004.

7.7 DURATION OF INSTITUTIONAL CONTROLS

Institutional Controls will remain in effect until a five-year review determines that they are no longer necessary.

7.8 PROCEDURES FOR MODIFYING OR TERMINATING INSTITUTIONAL CONTROLS

7.8.1 Modifying or terminating the Institutional Controls for Forest Park will involve determining the need for changes in this plan during the five-year review process, then implementing them. The five-year reviews will be performed by USACE, who will document the results of their findings in a report. USACE can recommend changes to the then-current Institutional Controls and provide the opportunity for stakeholder approval and modification.

7.8.2 The Forest Park Master Plan can be changed through coordination with Forest Park Advisory Board. Zoning controls can be modified through coordination with the St. Louis zoning department.

7.8.3 The MEC pamphlet can be modified to add identification of new hazards or provide different response actions. Distribution of the fact sheet can be ceased at any time it is determined to be unnecessary.

7.8.4 Five-year reviews can be discontinued any time that it is determined by the reviewers that a hazard from MEC no longer exists. This may include significant construction activities that uncover any MEC that may exist, or the use of new, currently non-existing technology that can reliably identify the presence or absence of subsurface MEC.

7.9 LAND USE

The land use for the entire site is recreational. Exposure to MEC on the ground surface and in the subsurface is depicted graphically in the conceptual site model included in this EE/CA report. Members of the public and grounds keepers may be exposed to MEC on the ground surface, but are not exposed to subsurface MEC because recreational activities are not intrusive. Construction activities involving earth moving, however, could potentially expose MEC contained in the subsurface. Land use is expected to remain the same for the foreseeable future.

7.10 RESIDUAL RISK

The institutional controls identified in this plan are capable of effectively protecting the human environment from MEC remaining at Forest Park from past DoD operations. Overall risk to humans from MEC exposure is low based on sparse density of MEC discoveries, the depth below the ground surface it occurs, and the unlikelihood that many items remain. Effective institutional controls can ensure future MEC discoveries, if any, would be responded to safely.

8 RECOMMENDED RESPONSE ACTION

8.1 INTRODUCTION

This purpose of this chapter is to recommend a response action. This recommendation is based on the evaluation conducted in Chapter 6. The selected response action is the most preferred alternative based on the three factors of effectiveness, implementability, and cost.

8.2 BACKGROUND

The recommended response action alternative for reducing the explosive safety risk to members of the public and ground intrusive workers represents interpretations and conclusions based on results of the TPP process and the ASR. The risk evaluation conducted in Chapter 5 indicated that risk from MEC within the AOC is extremely low. The current land uses in Forest Park and the concerns of City of St. Louis entities with regard to disruption of those current land uses were a factor in recommending a particular response action alternative.

8.3 RECOMMENDED ALTERNATIVE

The recommended response action alternative for the Forest Park site is Alternative 2, Institutional Controls. The controls associated with this alternative include distributing MEC educational/awareness materials to individuals most likely to encounter MEC (ground intrusive workers), and an MOA between USACE and the City of St. Louis mechanism to ensure such distribution occurs. A draft MEC educational/awareness pamphlet is included as Appendix L. This MOA also ensures that if an MEC item is discovered on site, the item will be handled and disposed of safely and appropriately. This alternative is the preferred and recommended response action because it is considered effective, although not as effective as the clearance based alternatives, most implementable, and least costly to execute.

8.4 IMPLEMENTATION OF THE RECURRING REVIEW PLAN

A recurring review team will be established by USACE and this response action will be reviewed at a minimum of every five years. Additionally, a site visit will be performed each year to ensure MEC educational/awareness materials are being distributed appropriately and consistently. The Draft Recurring Review Plan is included as Appendix G.

8.5 EFFECTIVENESS

Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, has the most favorable score for effectiveness. Alternative 3, Comprehensive Surface Clearance with Institutional Controls, is considered the second most effective alternative. Alternative 3, Institutional Controls, is considered the least effective of the three alternatives. However, based

on the low probability of encountering MEC on the surface, Alternative 3 is considered effective in reducing the limited explosive risk that exists within the AOC.

8.6 IMPLEMENTABILITY

Alternative 2, Institutional Controls, has the most favorable score for implementability. Alternative 3, Comprehensive Surface Clearance with Institutional Controls, is ranked second for this criterion, and Alternative 4, Comprehensive Subsurface Clearance with Institutional Controls, is considered the least implementable alternative.

8.7 COST

The cost associated with this alternative is approximately \$15,000 for the first year and \$6,000 for subsequent years. First year costs include task management and development of bilingual educational/awareness materials regarding MEC. These costs are one time costs and would not exist for out years. Costs after year one would only include a production run of the informational materials and a site visit to distribute the materials. These costs, broken down into Response Design (RD), Response Action (RA), and Long-Term Management (LTM) costs, are included as Table 8-1. Further details regarding the costs of Alternative 2 are included in Appendix E.

Table 8-1: Institutional Controls - Costs

Cost Category	Cost
Response Design (RD)	\$9,000
Response Action (RA)	\$6,000
Long –Term Management (LTM)*	\$6,000
Total	\$21,000

* Long-Term Management costs are one year of production of educational/awareness materials and site visit to distribute materials. Recurring Review Team and stakeholders will determine how long these costs continue.

9 QUALITY CONTROL (QC)

No fieldwork is being conducted as part of this EE/CA Report. Quality Control (QC) discussions below address document QC only.

9.1 QC METHODS USED

A QC Team was established at USACE, Omaha District, to provide QC review and comment on the Forest Park EE/CA Report. Pre-Draft copies of the report were provided to individual reviewers. Comments provided by the QC Team were tracked and incorporated into the Draft document. All comments were tracked on an internal comment tracking form. Any changes to the Pre-Draft document as a result of comments were also tracked on the form. If the comment did not result in a change to the document, an explanation was provided on the comment tracking form. After the QC review, comment tracking forms and copies of the Draft EE/CA Report were provided to the QC Team for back check regarding comment incorporation. The comment tracking forms are internal and are not included as part of the final document.

9.2 QC RESULTS

QC was conducted as described in the Section 9.1 of this EE/CA Report.

9.3 LESSONS LEARNED

Lessons Learned will be described in the Final EE/CA Report document.

10 REFERENCES

10 USC 2701, *Defense Environmental Restoration Program*

16 USC 1531-1544; 50 CFR 17, 401-424, 450-453 *Endangered Species Act*

16 USC 470; 36, CFR 60, 63, 68, 800; Executive Order 11593. *National Historic Preservation Act*.

29 CFR 1910. *Occupational Safety and Health Administration (OSHA) General Industry Standards*

29 CFR 1926. *Construction Industry Standards*

40 CFR 300. *National Oil and Hazardous Substance Contingency Plan*

EPA (U.S. Environmental Protection Agency) 1992. *Guidance on Implementation of Superfund Accelerated Cleanup Model (SACM) under CERCLA and NCP*, OSWER Publication 9203-1-03, PB93-963252.

EPA *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*, EPA/540-R-93-057

DOD (U.S. Department of Defense). *DoD Ammunition and Explosive Safety Standards*, DOD 6055.9 Std.

DOD Directive 1000.3. *Safety and Occupational Health Policy for the Department of Defense*

USACE (U.S. Army Corps of Engineers) 2003. *Safety and Health Requirements Manual*, EM 385-1-1

USACE. *Technical Project Planning (TPP) Process*, Engineer Manual, EM 200-1-2

USACE. *Public Participation in the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS)*, Engineer Pamphlet, EP 1110-3-8

USACE. *Ordnance and Explosives Response*, EP 1110-1-4009

USACE. *Ordnance and Explosives Response*, EP 1110-1-18

USACE. *Establishing and Maintaining Institutional Controls for OE Projects*, EP 1110-1-24

USACE. *Unexploded Ordnance Support During Toxic and Radioactive Waste and Construction Activities*, EP 75-1-2

USACE. *Basic Safety Concepts and Considerations for Ordnance and Explosive Operations*, EP 385-1-95a

USACE. *Explosive Safety Submissions*, EP 385-1-95b

USACE. *OE Risk Impact Assessment for OE EE/CA Evaluations*, IGD 01-01

USACE. *Implementation of Technical Project Planning (TPP) for Ordnance and Explosives (OE) Formerly Used Defense Sites (FUDS) Projects*, IGD 01-02

USACE (1997), *Archive Search Report, Findings, Forest Park Recreation Camp, St. Louis, MO*, September, 1997

USACE (1995), *DERP-FUDS, Inventory Project Report, Forest Park Recreation Camp, St. Louis, MO*, June 5, 1995

TM 9-1904, *Ammunition Inspection Guide*, March 1944, *Hand Book of the 3-inch Stokes Trench Mortar*, Jul 1921

10.1 APPLICABLE DATA ITEM DESCRIPTIONS:

DID OE-001.01 Type I Work Plan

DID OE-005-02.01 Technical Management Plan

DID OE-005-03.01 Explosives Management Plan

DID OE-005-06.01 Site Safety and Health Plan

DID OE-005-07.01 Location Surveys and Mapping Plan

DID OE-005-08.01 Work, Data, and Cost Management Plan

DID OE-005-09.01 Property Management Plan

DID OE-005-10.01 Sampling and Analysis Plan

DID OE-005-11.01 Quality Control Plan

DID OE-005-12.01 Environmental Protection Plan

DID OE-010.01 Engineering Evaluation/Cost Analysis (EE/CA) Report

DID OE-015.01 Accident/Incident Reports

DID OE-025.01 Personnel and Work Standards

DID OE-030.01 Site Specific Final Report

DID OE-040.01 Disposal Feasibility Report

DID OE-045.01 Report/Minutes, Record of Meetings

DID OE-055.01 Telephone Conversations/ Correspondence Records

DID OE-060.01 Conventional Explosives Safety Submissions (ESS)

DID OE-080.01 Monthly Status Report

DID OE-085.01 Weekly Status Report

DID OE-100 Analysis of Institutional Controls

DID OE-110.01 Recurring Review Plan

APPENDIX A
SCOPE OF WORK

APPENDIX B
SCRAP DISPOSITION DOCUMENTATION

Scrap Disposition documentation is not required for this EE/CA report.

APPENDIX C

DEMO ACTIVITY SUMMATION TABLES

Demo Activity Summation Tables are not required for this EE/CA Report.

APPENDIX D
INSTITUTIONAL ANALYSIS REPORT

APPENDIX E
COST BREAKDOWNS AND ASSUMPTIONS

APPENDIX F
RESPONSIVENESS SUMMARY

This section will be added after the public review session.

APPENDIX G
DRAFT RECURRING REVIEW PLAN

APPENDIX H
FINAL EE/CA WORK PLAN

APPENDIX I
PERSONAL INTERVIEW QUESTIONNAIRES

APPENDIX J
INCIDENT REPORTS

APPENDIX K
CUT AND FILL DIAGRAMS

APPENDIX L
DRAFT MEC AWARENESS PAMPHLET